No. 7 — *Bathonian Foraminifera of England*

By Richard Cifelli

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INTRODUCTION

Whereas the Jurassic megafauna of England has been intensively studied for over a century, the Foraminifera and other microscopic fossils have, until recently, received but scant attention. Before Macfadyen (1941) published his excellent account of the Foraminifera from the Green Ammonite Beds in the Lower Lias of the Dorset Coast there were perhaps two dozen papers in the literature dealing with the Jurassic Foraminifera of England. All of these were published before the turn of the century, and most of them contain but few descriptions or illustrations. In almost all instances they are concerned with the faunas of the Lias. Since World War II there has been a renewed interest in Foraminifera, largely through the efforts of

Barnard and his students. A number of important papers have appeared (Barnard, 1950a, 1952, 1953, 1956, 1957; Adams, 1957), but again, almost all of them thus far have dealt only with the Lias. No Foraminifera have ever been described from the English Bathonian and the only previous records of Foraminifera in this stage are a few lists of species and genera in the older literature. These are of little value because of the uncertainties in identification and nomenclature.

In this paper 104 species, subspecies and varieties (exclusive of attached forms) are described and their known stratigraphic occurrences are recorded. These include one species (*Massilina dorsetensis*) and one subspecies (*Vaginulina clathrata expensa*) which are new. There are, in addition, several previously undescribed varieties, but these are not given formal taxonomic status here.

No claim is made that this represents the entirety of the Bathonian foraminiferal fauna. The strata of the Bathonian are generally poorly exposed in England, and parts of them are completely concealed. As new road cuts and quarries make additional exposures available there will undoubtedly be descriptions of new and previously unrecorded species as well as additional records of stratigraphical occurrences of known forms. There are four foraminiferal faunules that can be distinguished, which should provide a framework for future faunal divisions of this stage. The faunules are provisional units and can not be used to establish zones at present, because their stratal limits are not known, and their relationships to larger Middle Jurassic faunal units within the European province are not yet known. However, the faunules can be recognized in Dorset and the Bath areas, where they occur in the same order of superposition. Consequently, they probably contain stratigraphically restricted species which should later prove useful in establishing zones based on Foraminifera.

The Bathonian fauna, like other Jurassic faunas, is characterized by the dominance of the Lagenidae. Representatives of this family occur in a large variety of sediments, and in practically all instances they are the most common forms in the foraminiferal assemblages. Other families are represented by few, unspecialized, genera and species.

It is well known that many species of Jurassic Lagenidae are highly variable. Only recently, however, have there been any attempts to describe the variation of species (Barnard, 1950a, b; Adams, 1957). Classification of specimens is difficult because species and genera do not have well defined morphological limits. Nevertheless, it is believed that recognition of variation is vital to an understanding of the evolution of the family; consequently many lagenid species are conceived here quite broadly.

Methods

Field work for this investigation was conducted during the summer of 1955. All of the samples are from surface outcrops and each of them weighed about 2 pounds before washing. The samples were prepared in the conventional manner of disaggregating in water, sometimes with the assistance of boiling, or adding hydrogen peroxide, and passing them through a 200-mesh screen. In some instances the sample was entirely picked clean, but most of the residues were so large that they were first quartered with a micro-splitter. In the records of species the following scale of relative abundance was used.

In each sample,

rare	corresponds to	1- 3 specimens
few	"	" 4- 7 "
common	"	" 8-19 "
abundant	"	" over 20 specimens

During the spring of 1956 I examined a number of collections containing species previously described from the Jurassic of Europe. Wherever specimens from these collections were used in the identifications of species they are noted in the discussion following the synonymies and descriptions of the species. The types and figured specimens are deposited at the Museum of Comparative Zoology, Harvard University.

Acknowledgements

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late Dr. W. J. Arkell of Cambridge University offered advice on collecting areas and general problems of Bathonian stratigraphy during the early stages of the investigation. Mr. P. C. Sylvester-Bradley of Sheffield University and Dr. D. T. Donovan of Bristol University provided additional advice on important matters of stratigraphy. To Mr. R. V. Melville of the British Geological Survey I am grateful for details of Bathonian sections in Northamptonshire and Lincolnshire.

I also wish to thank the following persons who have helped in many ways: Dr. C. G. Adams of the British Museum of Natural History, Dr. J. Roger of the Laboratory of Paleontology, Muséum National d'Histoire Naturelle, Paris, and Dr. H. Malz of the Senckenberg Museum, Frankfort. Mr. Stuart McNichol, a graduate student at University College, London, collaborated in some of the field work in the Bath and Dorset areas.

Finally, I am indebted to Dr. T. Barnard for assistance and the facilities provided at University College during my stay in London.

STRATIGRAPHY

The Bathonian Stage in England

The English strata included in the Bathonian Stage are shown in Figure 1, following Arkell's (1951, pp. 16-22) interpretation of d'Orbigny's definition of this stage.

In general, the Bathonian in England corresponds to the Great Oolite Series, a lithogenetic unit composed of a highly variable sequence of rocks, chiefly limestones, clays and marls between the Inferior Oolite below and the Oxford Clay and Kellaway Beds above. To Americans unaccustomed to British stratigraphic nomenclature, the term Series is apt to be confusing, as in America that term has been standardized in a time-rock sense, denoting a unit larger than a Stage, but smaller than a System. In Great Britain, however, the term is lithogenetic, and is used to unite distinct, but related, rock units without any time connotations. It is similar to the term Group, except that whereas Group combines two or more rock units of formational rank, Series combines rock units of all magnitudes, regardless of rank.

In general, the major units of the Great Oolite Series (often, but not always designated as formations) are as follows, in ascending order: Fuller's Earth Clay, Great Oolite Limestones,

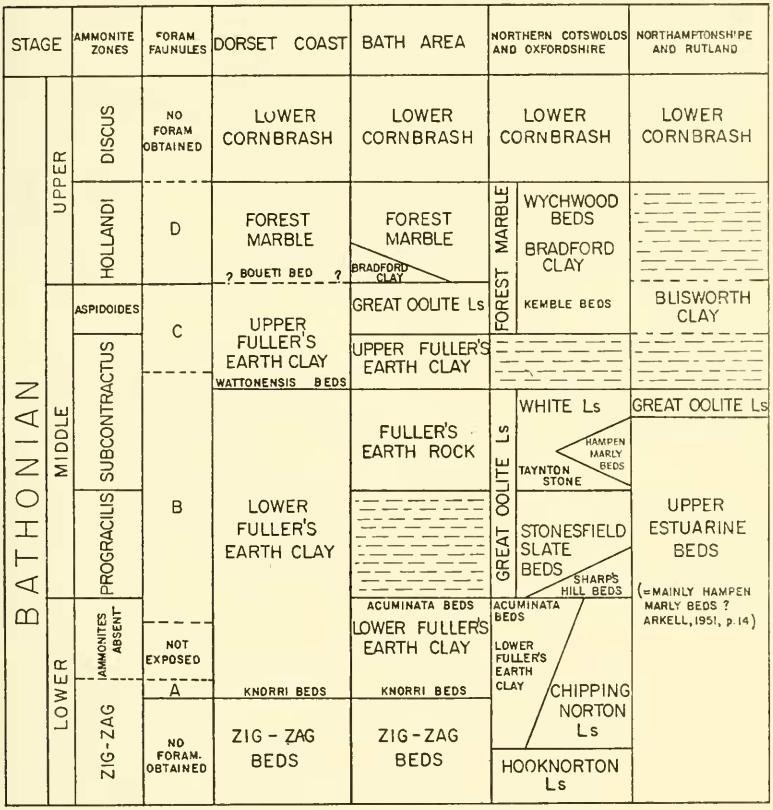

Figure 1. Inferred relationships of English Bathonian strata.

Forest Marble and Cornbrash. All of these strata are Bathonian except the Upper Cornbrash, which is Callovian. In addition, the

base of the Bathonian includes the *Zigzag* Beds, which comprise the upper few feet of the Inferior Oolite. No Foraminifera were collected from the *Zigzag* Beds or the Cornbrash.

The Great Oolite Series is highly variable and is characterized by great facies changes, particularly below the Forest Marble. In southern England, along the Dorset Coast, the Forest Marble directly overlies the Fuller's Earth Clay. In the Bath District the Great Oolite Limestone intervenes between the two formations, and farther north in the Cotswolds and Oxfordshire the Fuller's Earth Clay is mostly replaced by the Great Oolite Limestones. These pass northward into the Yorkshire basin, where the Bathonian consists mostly of sands and clays of nonmarine, deltaic origin. The maximum thickness of the Bathonian is in south Somerset, where it reaches a thickness of 500 feet (Arkell, 1951, p. 7). In Northamptonshire the thickness is only about 100 feet.

Ammonites, which are generally common throughout the English Jurassic and provide accurate guides for subdivisions of this system, are scarce and unevenly distributed in the Bathonian. They are common only in the *Zigzag* Beds and in the Cornbrash. In the Fuller's Earth Clays and much of the Great Oolite Limestones they are very rare or absent. It is only recently that the Bathonian has been divided into zones based on ammonites (Arkell, 1951, p. 21). It is doubtful, however, that these zones are as reliably established as others in the Jurassic. At Whatley in Somerset, for example, a recent large collection of ammonites from the *Rugitella* Beds, a few feet above typical *Subcontractus* Zone, yielded a mixture of Lower, Middle and Upper Bathonian species. Arkell (1957, p. 324) states, "The assemblage from the *Rugitella* Beds at Whatley is highly anomalous. It does not contain any of the zonal index species or genera of the Lower, Middle or Upper Bathonian (*Zigzagiceras, Morphoceras, Tulites, Morrisiceras, Clydoniceras*) but consists of a mixture of accessory ammonites individually considered characteristic of all 3 subdivisions of the Bathonian, but never previously found together." It appears that even these most honored of all index fossils may sometimes be susceptible to facies changes, as are other fossils.

Because of this lack of ammonites, correlations within the Bathonian are difficult, and the relationships of many of the strata are uncertain. Brachiopods are locally abundant, but their distribution is uneven, and they have been useful, thus far, only for local correlations. Foraminifera are abundant throughout most of the Bathonian, but this present effort represents but a beginning in the establishment of the Bathonian foraminiferal succession.

The stratigraphy of the English Bathonian has already been summarized (Woodward, 1894; Arkell, 1933, 1951, 1956; Arkell and Donovan, 1952), and the present account is limited to those details necessary to understanding the succession of Foraminifera. The major relationships of the strata are summarized in Figure 1, which has been compiled from many sources in the literature, but conforms mostly to the authority of Arkell.

Dorset Coast

The best English Bathonian exposures are found along the Dorset Coast between Bridport and Weymouth. A composite section showing the stratigraphic positions of the foraminiferal samples is given in Figure 2 and the stratigraphic occurrences of the foraminiferal species are shown in Table 1. The strata are nowhere exposed in their entirety and the section has been pieced together from a number of localities (Arkell, 1933, p. 250).

The Lower Fuller's Earth Clay is poorly exposed and most of it is never seen. Some of the clay occurs in the eastern part of Watton Cliff, but the beds there are faulted and the stratal relations are uncertain. The lower few feet of the Lower Fuller's Earth Clay are exposed at the top of Burton Cliff, between the Bredy River and Burton Bradstock. The cliff is not readily accessible and the present samples were obtained from a large boulder at the bottom of the cliff which had toppled from the top. The block contained 6 feet of Lower Fuller's Earth Clay, including a few inches of Scroff at its base, underlain by the *Zigzag* Bed and the Inferior Oolite.

The Fuller's Earth Rock does not extend into the Dorset Coast and overlying the Lower Fuller's Earth Clay in this area are the *Wattonensis* Beds (Kellaway and Wilson, 1941, p. 160),

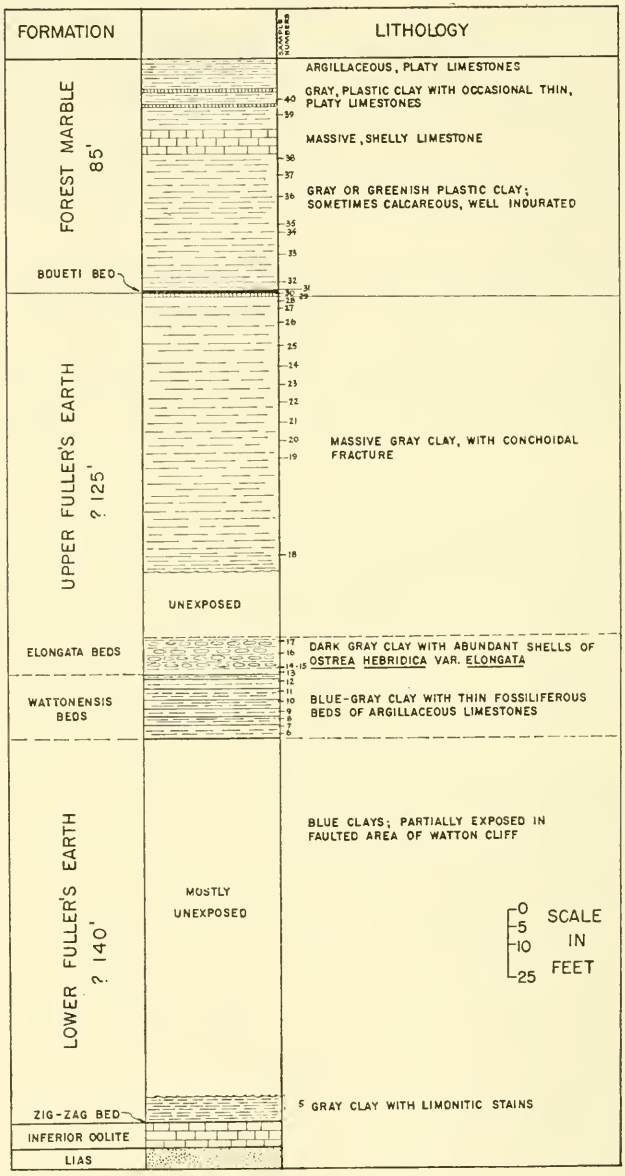

Figure 2. Composite section of Bathonian strata of the Dorset Coast.

a series of dark, argillaceous limestone bands with intervening clays. They occur along the beach at the base of Watton Cliff, just east of Eype Mouth. The beds strike NNE, parallel to the fault which extends through Eype Mouth, and dip sharply to the east. There are about eight limestone bands, each about one-half to one foot thick and as many intervening clays. The total thickness is estimated to be twenty-five feet (Buckman, 1922, p. 381), but the outcrop is mostly covered by the shingle and can be observed at the foreshore only at unusually low tides. Foraminifera were collected from the clay bands, immediately below each limestone.

At Watton Cliff there are approximately 100 feet of the Upper Fuller's Earth Clay exposed in the vertical cliff wall. The upper contact is clearly defined in the brow of the cliff, where the Upper Fuller's Earth Clay is overlain by the Forest Marble, with the *Boueti* Bed at the base. A much more accessible section is exposed 3 miles to the east at Cliff's End, Burton Bradstock, where there are about 60 feet exposed and overlain by the *Boueti* Bed (Arkell, 1933, p. 253). The clay is arenaceous and contains abundant fragments of quartz, chert and mica. The lower portion of the Upper Fuller's Earth Clay is concealed beneath the beach and is not visible in the vicinity of Bridport, but the lower beds are exposed 12 miles to the east, at Langton Herring. They consist of tough, dark gray clays containing masses of shells belonging mostly to *Ostrea hebridica* var. *elongata* Dutertre. This is the *Elongata* Bed, which is 12 feet thick at Langton Herring and is underlain by the *Wattonensis* Beds (Arkell, 1933, p. 252).

The base of the Forest Marble is represented by the *Boueti* Bed, a remarkably persistent fossiliferous marl, only one foot thick and characterized chiefly by the abundance of *Goniorhynchia boueti* (Davidson). This bed is best seen at Herbury along the West Fleet, but persists as far inland as Wincanton and Sherborne (Kellaway and Wilson, 1941, p. 162). In the past it has been customary to correlate the *Boueti* Bed with the Bradford Clay, as is shown in the chart in Figure 1. Recently, however, Sylvester-Bradley (1957, p. 27) has presented evidence to suggest that the *Boueti* Bed is older than the Bradford Clay and is the equivalent of the Bath Freestone in the Bath area.

The older, conventional correlation is retained here, however, pending a more complete statement on the problem.

Practically the entire Forest Marble is exposed at Watton Cliff, and is accessible at Fault Corner. The following section was obtained (measured by Cifelli and McNichol, 1955):

	feet
Platy, argillaceous limestone, gray on fresh surface, weathering rust brown; interbedded with thin marl bands; grades into clays below.	7
Gray or green soft, plastic clay, sandy, micaceous, with thin bands of argillaceous limestone becoming more numerous towards top.	21
Massive, oolitic limestone, gray on fresh surface, weathering buff, crossbedded; abundant broken shells, pectenids, oysters and few brachiopods.	10
Gray or green or brown soft clays, weathering to rust brown; sandy, micaceous; interbedded with thin, calcareous, well indurated clays containing shell fragments.	47
Total	85

Localities of foraminiferal samples:

Samples 1-5 were all collected from a single boulder at the base of Burton Cliff, 1.2 miles southeast of Bridport Harbour. The total stratigraphic interval represented in the boulder is about 6 feet.

Samples 6-13 were collected from the foreshore of Watton Cliff, at low tide level. Each sample was taken from the clay immediately underlying each of the argillaceous bands. The most westerly and stratigraphically lowest of these was located about 30 yards east of Eype Mouth.

Samples 14-15 were collected along the West Fleet, about 600 yards west of the Coast Guard Station at Langton Herring. Samples 16-17 are from the *Elongata* Beds, about 200 yards west of the ferry at Langton Herring.

Sample 18 was taken from the vertical cliff wall of Watton Cliff, about midway between Eype Mouth and West Bay, about 10 feet above the level of the beach.

Samples 19-27 are from Cliff's End, in the cove about 300 yards WNW of the Coast Guard Station.

Samples 28-31 were collected from Herbury, about 1 mile south of Langton Herring.

Samples 32-40 were collected from the western part of Watton Cliff, at Fault Corner, near Eype Mouth.

Bath Area

Stratigraphic investigations in the Bath area date back to the mapping of William Smith. Exposures at the present time are poor, however, and most of the quarries and railroad cuttings from which the succession was established are now covered. Only isolated portions of the sequence are revealed and the exact horizons of some of the exposures are uncertain. For this reason, Foraminifera collected from the Bath area have not been compiled into a single, composite check list. They are shown in individual tables for each formation, at the localities from which they were collected (Tables 2-11).

The most complete section of the Lower Fuller's Earth Clay in the Bath area was obtained by Richardson (1910, p. 426) from a railway cutting at Combe Hay, about 3 miles south of Bath. Richardson recorded 35 feet of the clay, containing *Zigzagiceras* at the base, resting on the Inferior Oolite. There was no trace of the Fuller's Earth Rock, but the occurrence of *Ostrea acuminata* in the upper layers suggested that almost the entire thickness of Lower Fuller's Earth Clay was represented (Arkell, 1933, p. 280). The cutting is now obscured, but 2 miles east of Combe Hay in the railway embankment at Midford there are 10-12 feet of the clay resting on the Inferior Oolite. The weathered, yellow clay which can be reached within a couple of feet of the grass covered surface yields numerous, moderately well preserved Foraminifera.

The Fuller's Earth Rock is well developed in the Bath area. It is still exposed in the road cut between Maperton and Charleton-Horetorne, where it rests on the Lower Fuller's Earth Clay. The section was described by Richardson (1909, p. 213) who recorded 22½ feet of Fuller's Earth Rock and 15 feet of Lower Fuller's Earth Clay. In the town of Box, 5 miles northeast of Bath, the upper part of the Lower Fuller's Earth Clay appears to be overlain by the Fuller's Earth Rock. The area has not

been mapped in detail and the stratal relations are not certain. However, in the summer of 1955 a drainage ditch was dug at the road intersection about 50 yards down hill from Rose Cottage in Box. It revealed a rubbly, oolitic limestone underlain by 6 feet of dark brown clay. Another ditch, about 10 feet below the first, exposed an additional few feet of clay. In view of the Old Series 1 inch map showing the Great Oolite Series at Box and Lycett's record of 148 feet of Fuller's Earth, including Fuller's Earth Rock at Box Tunnel (Arkell, 1933, p. 281), it appears likely that the upper part of the Lower Fuller's Earth Clay and the Fuller's Earth Rock were represented in the ditches. Foraminifera were collected from the clays (Table 4).

At Cross Ways Inn, a few miles south of Bath, at the intersection of the roads to Radstock and Timsbury, Cox (1941, p. 20) described the following section:

	feet
Marly clay (Upper Fuller's Earth)	2—0
Rubbly limestone (Fuller's Earth Rock proper), with pelecypods and brachiopods including species of *Rugitella*, *Ornithella*, *Rhynchonelloidea*, *Wattonithyris*	5—0
Mottled clay	5—0
Limestone	0—6
Clay with *Rhynchonelloidea turcheri*	1—6
Argillaceous limestone	0—6
Mottled clay	5—0
Clay with abundant *Ostrea acuminata*	1—0
Clay	3—0
Estimated thickness of beds underlying grass slope to top of Inferior Oolite	15—0

The section is unusual in that there are only 5 feet of rubbly limestone ("Fuller's Earth Rock proper") represented and 12½ feet of clay intervene between the limestone and the clay containing *Ostrea acuminata*. Normally the *Acuminata* Beds occur immediately below the Fuller's Earth Rock and traditionally they have been regarded as a constant paleontological horizon marking the top of the Lower Fuller's Earth Clay. However, this oyster was found to straddle the boundary and occur

in the Fuller's Earth Rock at Whatley (Sylvester-Bradley and Hodson, 1957, p. 315). The section at Cross Ways Inn is now covered with grass, but one sample was recovered about 4 feet below the surface which yielded a rich assemblage of Foraminifera (Table 6).

North of Bath the Fuller's Earth Rock splits into 2 separate limestone bands, an upper Tresham Rock and a lower Cross Hands Rock, separated by a clay bed (Hawkesbury Clay). No Foraminifera were obtained from these units.

The best known part of the Upper Fuller's Earth Clay is the commercial clay which occurs in a 5 or 6 foot bed near the top. It is a blue or green clay which weathers to a buff or yellow color, lacks plasticity and disintegrates completely in water. It has been mined for many years in the vicinity of Bath. At Midford it is separated from the overlying Great Oolite Limestones by 17½ feet of unworkable clay, while at Combe Grove there are 11½ feet of intervening clay (Woodward, 1894, p. 242). The commercial clay is presently being worked at the Combe Hay Fuller's Earth Works on Fosse Way, about 3 miles south of Bath. The Foraminifera collected there are shown in Table 7.

The top beds of the Upper Fuller's Earth Clay are exposed at Vernham Wood, about 1½ miles west of the Combe Hay Fuller's Earth Works, where the commercial clay is worked occasionally from small, open cast pits. The following section was obtained from one of these pits (measured by McNichols and Cifelli, 1955):

	feet
a — Rubbly, white oolitic limestone (Base of Great Oolite Limestones)	4—0
b — Green, plastic clay with thin, oolitic marl at the top	2—6
c — Mottled, carbonaceous, dark gray and black plastic clay	1—3
d — Buff, oolitic limestone with 2″ clay band in middle	1—9
e — Green clay, weathering buff, calcareous, non-plastic (probably the top of the commercial Fuller's Earth)	2—4

The Foraminifera are shown in Table 8. Additional Foraminifera from the top part of the Upper Fuller's Earth Clay were obtained on Henley Hill, 1 mile south of Box, where the clay is overlain by the Great Oolite Limestones (Table 9).

The Forest Marble overlies the Great Oolite Limestones (which separate it from the underlying Upper Fuller's Earth Clay) and consists mostly of shelly, oolitic limestones and clays. At Bradford-on-Avon, 5 miles east of Bath, the base of the Forest Marble is represented by the Bradford Clay, consisting of 10 feet of clay with thin layers of argillaceous limestone. At the bottom is a distinctive fossil bed which occurs intermittently at the same horizon from Somerset to Oxfordshire (Arkell, 1933, p. 269). It has been customary to correlate this fossil bed with the *Boueti* Bed of Dorset, although Sylvester-Bradley (1957, p. 27) has suggested a correlation of the Bradford Clay with the *Digona* Beds, a fossiliferous horizon somewhat higher in the Forest Marble of Dorset. The Foraminifera from the Bradford Clay are shown in Table 10.

The Forest Marble is revealed below the surface in the Corsham Monk Quarry, on Monk Lane near Gastard, where the Bath Freestone is mined for building stone. At the bottom of the quarry there are 28 feet of Bath Freestone overlain by 3 feet of the Upper Rag. Above this there are approximately 70 feet of Forest Marble in the shaft of the quarry, consisting of limestones, clays and marls. The clays are wet and weathered, yielding relatively few, poorly preserved Foraminifera (Table 11).

Northern Cotswolds and Oxfordshire

In this region the Great Oolite Series is dominantly of a calcareous facies, composed chiefly of limestones with lesser amounts of clay and marl. The relationships of the strata have been described by Arkell (1951) and Arkell and Donovan (1952).

An almost complete section of the Great Oolite Series is exposed along the railway between Chedworth and Cirencester in East Gloucestershire. The cuttings extend a distance of 8 miles and were described by Richardson (1911a; 1933). The succession includes beds ranging from the Lower Fuller's Earth Clay

at the base to the Kemble Beds (Lower Forest Marble) at the top. Although the railway embankments are now partially covered, many of the beds may still be observed. The Hampen Marly Beds and Taynton Stone were not included in Richardson's original description of the section, but were later identified as beds 33-35 and 36, respectively, of Richardson by Arkell and Donovan (1952, p. 246) and Green and Melville (1956, pp. 10-11). The Stonesfield Slate Beds have never been positively identified along the railroad, but Green and Melville (1956, p. 3) believe that they may be present below the Chedworth Station.

Most of the Great Oolite Limestones are exposed in the Hampen railway cuttings, about 5 miles east of Cheltenham. The section was described by Richardson (1929, pp. 102-106), and includes beds ranging from the Lower Fuller's Earth Clay to the White Limestone. The Taynton Stone and the Hampen Marly Beds are particularly well represented in this sequence.

In Oxfordshire the upper part of the Bathonian is represented in the quarry of Kirtlington Cement Works, Kirtlington. The section extends from the White Limestone at the base to the Cornbrash at the top. The lower part of the sequence is exposed in the Sharp's Hill Quarry near Hook Norton, northern Oxfordshire. The section includes the Hook Norton and Chipping Norton Limestones, which replace the Lower Fuller's Earth Clay at the base, and the Lower and Upper Sharp's Hill Beds.

Foraminifera collected from the northern Cotswolds and Oxfordshire are shown in Tables 12-16. Because of the dominantly calcareous nature of the Bathonian in this region suitable foraminiferal samples are difficult to obtain, and portions of the sequence have been but sparsely sampled. No Foraminifera were obtained from the Lower Fuller's Earth Clay or the Cornbrash.

Northamptonshire and Rutland

Foraminifera were collected only from the Upper Estuarine Beds, a series of various colored clays with some sandy shelly beds and limestones. They include both freshwater and marine deposits. Foraminifera are not common (Tables 17-18), but there are numerous ostracods and charophytes.

DISTRIBUTION OF FORAMINIFERA

The present records of species are still too meager to establish the succession of Bathonian Foraminifera in England. Moreover, many of the Jurassic Foraminifera are yet to be described, so that the total ranges of the Bathonian species and their distribution throughout the European province cannot as yet be determined. Consequently, formal subdivision of Bathonian strata based on Foraminifera would hardly be justified at this time. The present records of occurrences of species (Tables 1-18) do reveal that there are 4 faunules that can be recognized in the Dorset and Bath areas. In both of these areas the faunules occur in the same order of superposition and therefore probably contain elements diagnostic of faunizones. North of Bath, where the strata are dominantly of a calcareous facies, the foraminiferal assemblages are generally less rich, containing fewer species. The preservation is often poor and the assemblages are much less distinctive; the faunules cannot be recognized north of Bath.

Faunule A

This faunule occurs in the basal few feet of the Lower Fuller's Earth Clay in Dorset and Bath. The species which have been observed to occur only in this faunule are: *Vaginulina macilenta, Frondicularia nodosaria* var. A and *Lenticulina quenstedti* var. A. Although not restricted, *Lenticulina galeata* and *Planularia eugenii* are particularly common here. The following species occur in faunule A and succeeding faunules but have not been recorded from strata older than Bathonian in England: *Dentalina oolithica, Lenticulina quenstedti (sensu lato), L. tricarinella, Nodosaria opalini* and *Trochammina hacusleri.* Species of faunule A, not recorded from the succeeding faunules, but characteristic of the Lias are: *Vaginulina clathrata, Frondicularia lignaria* and *Nodosaria liassica.*

Faunule B

This faunule has been recognized in the upper beds of the Lower Fuller's Earth Clay, the Fuller's Earth Rock and the *Wattonensis* Beds. Common and characteristic of this faunule,

though not restricted to it, are: *Planularia beierana, Lenticulina tricarinella* and *L. munsteri.* Hold-overs from the previous faunule which have not been observed to range above this one are: *Citharina colliczi, Nodosaria* aff. *N. prima, Lenticulina quenstedti* var. B, *L. tricarinella,* and *Planularia eugenii.* Species not occurring in faunule A, but occurring in faunule B and succeeding faunules are: *Dentalina propinqua, Nodosaria pectinata, Frondicularia spissa* and *Vaginulina clathrata cypensa* n. subsp.

Faunule C

This faunule is characteristic of the Upper Fuller's Earth Clay in the Dorset and Bath areas. Common and characteristic, though not restricted to this faunule, are: *Dentalina intorta, Nodosaria opalini, Frondicularia nodosaria, Epistomina stelligera* and *Lenticulina subalata.* Species occurring in faunules C and D but not observed in previous faunules are: *Citharina heteropleura* and *Dentalina* aff. *communis.* Species occurring in this and previous faunules but not faunule D are *Vaginulina harpa* and *Nodosaria pectinata.*

Faunule D

This faunule characterizes the Forest Marble, including the *Boueti* Bed and the Bradford Clay. It is very similar to faunule C, but species of *Lenticulina* are decidedly less common here. The most characteristic aspect of Faunule D is the common, almost restricted occurrence of *Massilina dorsetensis* n. sp. The lowest observed occurrence of this species was in the beds immediately underlying the *Boueti* Bed at Herbury (Sample 30). *Nodosaria clavula* and *Frondicularia intumescens* have not been observed in other faunules, but both of these species are rare. *Vaginulina clathrata cypensa* n. subsp. and *Dentalina subplana* make their last appearances in the *Boueti* Bed and Bradford Clay, the basal beds in which this faunule occurs.

SYSTEMATIC DESCRIPTIONS

Phylum PROTOZOA

Order FORAMINIFERA

Family SACCAMMINIDAE

Genus THURAMMINA Brady, 1879

THURAMMINA TUBEROSA Haeusler

Plate 1, figure 29

Thurammina tuberosa Haeusler, 1890, p. 49, pl. 6, fig. 24; pl. 7, figs. 6-9.
Thuramminopsis canaliculata Haeusler, 1890, p. 50, pl. 7, figs. 1-5; pl. 8, figs. 4-6.
Thurammina papillata, Frentzen (*non* Brady), 1944, p. 322, pl. 17, figs. 1-9.

The present specimens are large, globular and little compressed. The walls are composed of very fine grains, with abundant cement, so that they appear almost calcareous. There are a number of tiny apertures on various parts of the test which have the appearance of pin holes. The shapes are irregular, but the specimens agree with the figures cited.

Family REOPHACIDAE

Genus REOPHAX Montfort, 1808

REOPHAX MULTILOCULARIS Haeusler

Plate 1, figures 6-7

Reophax multilocularis Haeusler, 1890, p. 28, pl. 3, figs. 9-11, 26.
Reophax multilocularis, Bartenstein and Brand, 1937, p. 133, pl. 5, fig. 8; pl. 8, fig. 8a-b; pl. 10, fig. 9; pl. 11a, fig. 5; pl. 15a, fig. 4; pl. 15c, fig. 2.
Reophax scorpiurus, Bartenstein and Brand (*non* Montfort), 1937, p. 134, pl. 4, fig. 7; pl. 5, fig. 9.

This species is very rare, and generally poorly preserved in the present material. The arenaceous wall is moderately coarse, and there are four or five chambers which are slightly higher than broad. The aperture is terminal and rounded. In one specimen the test is slightly curved at the base, but there is no indication of a coil.

Family LITUOLIDAE

Genus FLABELLAMINA Cushman, 1928

FLABELLAMINA ALTHOFFI Bartenstein

Plate 1, figures 25-26

Flabellamina althoffi Bartenstein *in* Bartenstein and Brand, 1937, p. 187, pl. 14a, fig. 8a-b; pl. 15a, fig. 41a-b.

The specimens are higher in relation to breadth, but otherwise compare favorably with the types of the species. The arenaceous wall consists of large grains mounted in abundant calcareous cement, which gives the test a smooth appearance. The grains are generally quartz, but oolites and occasional shell fragments also occur.

This species superficially resembles *Triplasia bartensteini*, and may possibly represent a flattened variant of the latter. No actual transitions between the two forms, however, were observed.

Genus AMMOBACULITES Cushman, 1910

AMMOBACULITES AGGLUTINANS (d'Orbigny)

Plate 1, figure 1

Spirolina agglutinans d'Orbigny, 1846, p. 137, pl. 7, figs. 10-12.

Haplophragmium coprolithiforme, Deeke (*non* Schwager), 1884, p. 20, pl. 1, fig. 5.

Haplophragmium coprolithiforme, Haeusler, 1890, p. 33, pl. 4, figs. 7, 20.

Ammobaculites agglutinans, Franke (*non* Schwager), 1936, p. 127, pl. 12, fig. 25.

Ammobaculites agglutinans, Bartenstein and Brand, 1937, p. 186, pl. 4, fig. 14; pl. 5, fig. 78; pl. 6, fig. 4a-b; pl. 8, fig. 38a-c; pl. 10, fig. 45a-b; pl. 11a, fig. 19a-b; pl. 11b, fig. 28a-b; pl. 12a, fig. 22; pl. 13, fig. 23; pl. 14b, fig. 19.

Bartenstein and Brand (1937, p. 186) state that the wall material is variable in this species. Among the Bathonian forms the wall is remarkably uniform. It is composed of very fine arenaceous particles, and usually contains a large amount of pyrite. The tests are small, and mostly uncoiled.

The species occurs throughout the Bathonian, but individuals are few.

Ammobaculites fontinensis (Terquem)

Plate 1, figures 2-5

Haplophragmium fontinense Terquem, 1870b, p. 337, pl. 24, figs. 29, 30.
Ammobaculites fontinensis, Franke, 1936, p. 127, pl. 12, fig. 25.
Ammobaculites fontinensis, Bartenstein and Brand, 1937, p. 186, pl. 5, fig. 79a-b; pl. 6, fig. 43; pl. 8, fig. 37a-d; pl. 10, fig. 44; pl. 11b, fig. 27; pl. 12a, fig. 21a-b; pl. 13, fig. 22.
Ammobaculites fontinensis, Barnard, 1950b, p. 4, pl. 1, fig. 2.

This species shows little selection in the nature of the wall material, which appears to be determined by the nature of the enclosed sediment. The wall is finely to coarsely arenaceous, consisting mostly of quartz grains, but occasionally oolites as well. The degree of coiling is highly variable, and some specimens are practically linear with a minute spire, while others are completely coiled.

Family TEXTULARIDAE

Genus TEXTULARIA Defrance, 1824

Textularia jurassica Gumbel

Textularia jurassica Gumbel, 1862, p. 228, pl. 4, fig. 17a-b.
Textularia franconica Gumbel, 1862, p. 229, pl. 4, fig. 18a-b.
Textularia agglutinans, Blake (*non* d'Orbigny), 1876, p. 472, pl. 17, fig. 37.
Textularia jurassica Paalzow, 1932, p. 94, pl. 4, figs. 21-23.
Textularia agglutinans, Bartenstein and Brand, 1937, p. 182, pl. 14a, fig. 5a-b; pl. 14c, fig. 16; pl. 15a, fig. 40a-c; pl. 15b, fig. 3a-c; pl. 15c, fig. 21a-b.
Textularia jurassica, Seibold and Seibold, 1955, p. 98, pl. 13, fig. 1; text fig. 2a.

Specimens are rare, and agree well with topotypes from the Gumbel locality.

Material deposited at M.C.Z. No. 3306.

Family VERNEUILINIDAE

Genus VERNEUILINA d'Orbigny, 1840

Verneuilina mauritii Terquem

Verneuilina mauritii Terquem, 1866a, p. 448, pl. 18, fig. 18a-b.
Verneuilina georgiae Terquem, 1866a, p. 448, pl. 18, fig. 19a-b.
Verneuilina mauritii, Franke, 1936, p. 126, pl. 12, figs. 22, 23.

Verneuilina mauritii, Bartenstein and Brand, 1937, p. 183, pl. 1a, fig. 22.
Verneuilina mauritii, Cushman, 1946, p. 6, pl. 1, figs. 1-2.
Verneuilina mauritii, Usbeck, 1952, p. 385, pl. 14, fig. 1D.

There is only one specimen and it agrees well with other described forms of this species except that the early part of the test is slightly arched.

Material deposited at M.C.Z. No. 3307.

Family SILICINIDAE

Genus PROBLEMATINA Borneman, 1874

?Problematina cf. P. liassica (Jones)

Plate 1, figure 8

One specimen recovered from the *Elongata* Beds at Langton Herring superficially resembles *Problematina liassica* as figured by Macfadyen (1941, p. 19, pl. 1, figs. 9-11). The pillars are well seen on the ventral surface, but the specimen is otherwise poorly preserved and largely replaced by pyrite. The composition of the wall is therefore uncertain; but the granular appearance suggests that it is arenaceous, in which case it would differ from the forms analyzed by Macfadyen.

This species has been previously reported from the Lias only.

Genus HAPLOPHRAGMIUM Reuss, 1860

Haplophragmium suprajurassicum Schwager

Plate 1, figures 9-10

Haplophragmium suprajurassicum Schwager, 1865, p. 92, pl. 2, fig. 1.
Haplophragmium aequale, Bartenstein and Brand (*non* Roemer), 1937, p. 187, pl. 12a, fig. 24; pl. 13, fig. 25a-b; pl. 14a, fig. 9a-b; pl. 14b, fig. 20a-b; pl. 15a, fig. 42.

The walls are generally coarsely arenaceous, but the size of the grains is variable, and occasional specimens are fine grained. There is a slight tendency towards uncoiling, with only one or two chambers beyond the coil.

Genus TRIPLASIA Reuss, 1853

Triplasia bartensteini Loeblich and Tappan

Plate 1, figure 11

Triplasia variabilis, Bartenstein and Brand (*non* Brady), 1937, p. 185, pl. 14a, fig. 6.

Triplasia bartensteini Loeblich and Tappan, 1952, p. 8, pl. 1, fig. 4.

The cross-section of this species is highly variable, which is also characteristic of other species of *Triplasia*. Triradiate forms intergrade imperceptibly into quadrate forms, and I agree with Loeblich and Tappan (1952) in suppressing the genera *Tetraplasia* Bartenstein and *Centenarina* Majzon which are distinguished from *Triplasia* on the quadrate form of the cross-section. Some of the specimens are somewhat compressed, but no transition to the specimens included here in *Flabellamina althoffi* was observed. The height of the spire is also variable, and in some specimens it comprises about half of the test, while in others it is minute, though always conspicuous.

This species is common is certain beds of the Upper Fuller's Earth Clay at Dorset and Vernham Wood, near Bath.

Family MILIOLIDAE

Genus MASSILINA Schlumberger, 1893

In redescribing some of the species of d'Orbigny, Schlumberger (1893) erected the genus *Massilina* for those species of *Spiroloculina* d'Orbigny in which quinquiloculine growth of the test was highly developed. It differs, therefore, from *Spiroloculina* in degree only, and does not possess any distinctive morphological features. The two genera overlap considerably, and as mentioned by Wood and Barnard (1946, p. 83), there would be great difficulty in producing natural groups from specimens involved in these genera. The evolutionary significance of the degree of development of the quinqueloculine growth stage has yet to be demonstrated, and perhaps there is no adequate way of distinguishing the two genera. Pending further study, however, the genus *Massilina* is retained here for those specimens in which the major part of the test is quinqueloculine and the latter part is planar.

MASSILINA DORSETENSIS n. sp.

Plate 1, figures 15-17

Diagnosis. Test small, suboval in outline, slightly biconvex in cross-section, with thin, somewhat transparent wall; eight

chambers, each half a whorl in length and increasing in size as added, the first six arranged in a quinqueloculine series, the last two opposite; sutures flush, producing a smooth surface on both sides of test; proloculus minute, spherical; aperture simple, without tooth.

Discussion. All of the proloculi examined were minute, showing no appreciable differences in size, so that microspheric and megalospheric generations are not distinguishable in the present material. The species is distinctive, although it varies considerably in size, and to a lesser extent in thickness and ratio of width to length.

This species most closely resembles *Spiroloculina lanceolata* (Terquem and Berthelin), from which it may be directly descended. It is separated from the latter by the much greater development of the quinqueloculine stage and the lack of a long neck on the last chamber.

This species is common in the Upper Fuller's Earth Clay and Forest Marble, but was not observed at lower horizons.

Greatest length of holotype: .35 mm.

Greatest width of holotype: .18 mm.

Greatest thickness of holotype: .06 mm.

Material deposited at M.C.Z. No. 3311C1.

Genus SPIROLOCULINA d'Orbigny, 1826

SPIROLOCULINA LANCEOLATA (Terquem and Berthelin)

Plate 1, figures 18-19

Quinqueloculina lanceolata Terquem and Berthelin, 1875, p. 84, pl. 7, fig. 7a-b.

Quinqueloculina ovula Terquem and Berthelin, 1875, p. 85, pl. 7, fig. 8a-b.

Quinqueloculina rotundata Terquem and Berthelin, 1875, p. 85, pl. 7, fig. 10a-b.

Quinqueloculina compressa Terquem and Berthelin, 1875, p. 85, pl. 7, fig. 11a-b.

Quinqueloculina contraria Terquem and Berthelin, 1875, p. 85, pl. 7, fig. 12a-b.

The early portion of the test is very small, and consists of a variable number of chambers arranged in a quinqueloculine fashion. The last two chambers are opposite. The final one is characterized by a rather long neck, but this is found only on

the better preserved specimens. The resemblances and differences with *Massilina dorsetensis* have already been noted above: it might be added here that *Spiroloculina lanceolata* is generally smaller and slimmer, and the quinqueloculine portion more condensed.

This species is fairly common throughout the English Bathonian.

Family OPHTHALMIDIIDAE

Genus CORNUSPIRA Schultze, 1854

Cornuspira liasina Terquem

Plate 1, figures 27-28

Cornuspira liasina Terquem, 1866b, p. 474, pl. 19, fig. 4a-b.
Cornuspira orbicula Terquem and Berthelin, 1875, p. 17, pl. 1, fig. 12a-e.
Cornuspira orbicula, Bartenstein and Brand, 1937, p. 137, pl. 1a, fig. 3a-b; pl. 1b, fig. 3; pl. 2a, fig. 3a-b; pl. 2b, fig. 5; pl. 3, fig. 14; pl. 4, fig. 9; pl. 5, fig. 7; pl. 6, fig. 6a-b; pl. 8, fig. 7a-b; pl. 10, fig. 6a-b; pl. 12a, fig. 2a-b; pl. 12b, fig. 1; pl. 14c, fig. 2.
Cornuspira liasina Bartenstein and Brand, 1937, p. 131, pl. 4, fig. 8.

Coiled, tubular forms are abundant in the English Bathonian, but their relationships are difficult to ascertain because of the minuteness of the test and the imperfect preservation of the wall. Many specimens included here may actually belong to *Spirillina* or *Ammodiscus*. The forms are being investigated at present by Mr. Stuart McNichol of University College, London. Mr. McNichol is using very high magnification, and is studying the wall structure and growth plan of the early part of the test in great detail. His results will undoubtedly shed new light on the relationships of these forms, and the distributional patterns of species of *Cornuspira*, *Spirillina* and *Ammodiscus* will probably require some revision.

Genus SPIROPHTHALMIDIUM Cushman, 1927

Spirophthalmidium concentricum (Terquem and Berthelin)

Plate 1, figures 12-14

Spiroloculina concentricum Terquem and Berthelin, 1875, p. 80, pl. 7, figs. 1-4.

Spirophthalmidium tenuissimum Paalzow, 1932, p. 100, pl. 5, figs. 11-13.
Spirophthalmidium concentricum, Franke, 1936, p. 123, pl. 12, figs. 15, 17.
Spirophthalmidium concentricum, Bartenstein and Brand, 1937, p. 181, pl. 2b, figs. 37, 38; pl. 4, fig. 16; pl. 5, fig. 71a-b; pl. 8, fig. 36; pl. 13, fig. 21; pl. 15a, fig. 39a-b.

The proloculus and early spiral are minute, but under ordinary magnifications the specimens can be seen to lack clearly defined ophthalmid structure. The validity of the genus has been questioned, but I agree with Wood and Barnard (1946, p. 87) that the name should be retained until the relationships of the Ophthalmidiidae are better understood pending further study of the living representatives.

Family TROCHAMMINIDAE

Genus TROCHAMMINA Parker and Jones, 1859

TROCHAMMINA HAEUSLERI (Galloway)

Plate 1, figures 21-22

Valvulina triangularis, Haeusler (*non* d'Orbigny), 1890, p. 75, pl. 12, figs. 23, 24.
Valvulina conica, Haeusler (*non* Parker and Jones), 1890, p. 76, pl. 12, figs. 27-35.
Tritaxis haeuslcri Galloway, 1933, pl. 19, fig. 2a-b.
Valvulina (?) *haeusleri,* Cushman, 1937, p. 4, pl. 1, fig. 1.
Valvulina (?) sp. Cushman, 1937, pl. 1, figs. 2-4.

Test small, finely arenaceous with much cement, conical, chambers arranged in a trochoid spiral, about four to a whorl in the early portion, later only three; sutures flush; proloculus tiny, globular, alternate generations not apparent; aperture a poorly defined slit at base of last chamber in the umbilical region.

Haeusler did not figure a side view of this form which Galloway later used as the type of the species. Galloway interpreted the test as being flat, and apparently on this basis referred the species to *Tritaxis.* In the present specimens the height is variable, but the majority of tests are distinctly conical and only occasional ones are flattened. They agree very well with Haeusler's figures, and on the basis of growth plan and aperture it seems best to refer the species to *Trochammina.*

The species clearly differs from *Valvulina triangularis* Parker and Jones, a recent form, and Galloway's usage of the name is otherwise adhered to.

Trochammina globigeriniformis (Parker and Jones) 1863

Plate 1, figures 23-24

Haplophragmium globigeriniformis, Haeusler (*non* Parker and Jones), 1890, p. 36, figs. 193-195.

Trochammina globigeriniformis, Cushman, 1920, p. 78, pl. 16, figs. 5-6 (1918-31).

Trochammina globigeriniformis, Seibold and Seibold, 1953, p. 46, text figs. 5-6.

There are three or four chambers in the last whorl and the aperture is not visible. The amount of cement is variable, and some specimens are distinctly arenaceous while others are almost completely calcareous. The chambers are generally bulbous, but occasionally they are compressed, probably due to squashing.

The Jurassic forms are generally smaller than the recent counterparts, but otherwise they are morphologically identical. This appears to be an example of a very long-ranged species.

Specimens are rare, but occur sporadically throughout the Bathonian.

Trochammina sp.

Plate 1, figure 20

The material consists of two specimens which resemble *Trochammina globigeriniformis*, but are less trochoid and are flatter. They are also similar to *Trochammina canariense* (d'Orbigny) figured by Haeusler (1890, p. 34, pl. 4, figs. 1-3), but these are broader and have fewer chambers in the last whorl.

Family LAGENIDAE

Genus LENTICULINA Lamarek, 1804

Lenticulina galeata (Terquem)

Plate 2, figures 15-17

Cristellaria galeata Terquem, 1870a, p. 444, pl. 16, fig. 15a-b.

Cristellaria subangulata, Bruckman, (*non* Reuss), 1904, p. 22, pl. 3, fig. 9.

Test smooth, finely perforate, slightly involute, generally biconvex with slight depression in umbilical area, some specimens triangular in cross-section; periphery rounded, mostly close coiled, but occasionally uncoiled in later portion; chambers

numerous, six to ten in the last whorl, increasing in size as added, last ones inflated; sutures deeply depressed, with moderately strong ribs along the margins which extend to the keel; well developed keel throughout but indented at the sutures; aperture radiate, terminal, projecting slightly at peripheral margin.

Most of the tests are biconvex, but some have practically parallel sides, while others are triangular in cross-section, as in the genus *Saracenaria*. The ribbing along the margins of the sutures also exhibits some modification. Most often the ribs are quite strong, but occasionally they are weakly developed, and on one specimen observed they were completely inconspicuous. Occasionally a weak circular rib is developed, as in *L. quenstedti*, and except for the depression of the sutures such specimens are difficult to distinguish from the latter species .

Terquem's figure of this species does not show the ribs along the margins of the depressed sutures. At the Muséum d'Histoire Naturelle, Paris there are two specimens of this species in the Terquem collection, and ribs are well developed in both.

This species is common in the Lower Fuller's Earth Clay, but isolated specimens appear throughout the remainder of the Bathonian.

Lenticulina multangulosa (Schwager)

Plate 2, figure 14

Cristellaria multangulosa Schwager, 1865, p. 126, pl. 6, fig. 3.
Lenticulina (Astacolus) multangulosa, Seibold and Seibold, 1953, p. 56, pl. 5, fig. 12.

The angular periphery of this species is characteristic. Schwager's figure shows six chambers, and the last two are decidedly uncoiled, arranged in a linear series. Otherwise the present specimens agree well with the original figure.

Lenticulina munsteri (Roemer)

Plate 2, figures 3-5

Robulina munsteri Roemer, 1839, p. 48, pl. 20, fig. 29.
Cristellaria inflata Schwager, 1865, p. 125, pl. 6, fig. 16.

Cristellaria (*Lenticulina*) *munsteri*, Bartenstein and Brand, 1937, p. 174, pl. 3, fig. 30a-b; pl. 4, fig. 69a-e; pl. 6, fig. 34a-d; pl. 9, fig. 49a-e; pl. 10, fig. 38a-b; pl. 11a, fig. 13a-d; pl. 11b, fig. 19a-d; pl. 12a, fig. 16a-b; pl. 12b, fig. 15a-e; pl. 13, fig. 36; pl. 14b, fig. 14a-e; pl. 14c, fig. 13a-b; pl. 15a, fig. 34a-e; pl. 15c, fig. 19a-c.

Cristellaria (*Astacolus*) *matutina*, Bartenstein and Brand (*non* d'Orbigny), 1937, p. 172 (pars), pl. 4, fig. 79; pl. 5, fig. 53; pl. 6, fig. 33.

Cristellaria munsteri, Macfadyen, 1941, p. 31, pl. 2, fig. 23a-b.

Cristellaria matutina, Macfadyen, 1941, p. 30, pl. 2, fig. 22.

Lenticulina munsteri, Barnard, 1950b, p. 7, pl. 2, fig. 1.

Lenticulina (*Lenticulina*) *munsteri*, Seibold and Seibold, 1955, p. 104, text fig. 4a-c.

Lenticulina (*Astacolus*) *matutina*, Seibold and Seibold, 1955, p. 108, text fig. 4k-l.

Many specimens have a slight keel, the presence of which appears to be determined partially by preservation. Possibly the Jurassic forms referred to as *Lenticulina cultrata* (Montfort) should be included here, as this species is distinguished from *L. munsteri* only by the presence of the keel. However, the keels on the English Bathonian specimens are always small, and never highly developed as in the described forms of *L. cultrata*.

This species occasionally exhibits a marked tendency to uncoil, and in some assemblages there occur transitions from the typical, tightly coiled types to linear forms with a small spire.

In the uncoiled individuals the sutures tend to become depressed in the last stages, and the last chambers are sometimes bulbous. The uncoiled individuals are identical with some of those of *Lenticulina matutina* (d'Orbigny), and probably many specimens identified as this latter species are actually variants of *L. munsteri*.

Lenticulina quenstedti (Gumbel)

Plate 2, figures 6-7

Cristellaria quenstedti Gumbel, 1862, p. 226, pl. 4, fig. 2a-b.

Cristellaria polonica Wisniowski, 1890, p. 222, pl. 10, fig. 3.

Cristellaria quenstedti, Klahn, 1921, p. 49, pl. 2, figs. 16, 18-25.

Cristellaria quenstedti, Paalzow, 1932, p. 102, pl. 6, figs. 3-5.

Cristellaria (*Lenticulina*) *quenstedti*, Bartenstein and Brand, 1937, p. 177, pl. 11a, fig. 16a-c; pl. 11b, fig. 23a-c; pl. 12a, fig. 19a-d; pl. 12b, fig. 7a-c; pl. 13, fig. 39a-c; pl. 14, fig. 17a-b; pl. 15a, fig. 36a-c; pl. 15c, fig. 20a-b.

Lenticulina quenstedti Barnard, 1952, p. 339, text fig. A-6.
Lenticulina (Lenticulina) quenstedti Seibold and Seibold, 1955, p. 105, pl. 13, fig. 3.

This common Jurassic species has been described many times. Most characteristic are the raised sutural ribs which converge at the umbilical area and are connected by a circular rib. The specimens figured by Bartenstein and Brand have ribs which are beaded, and differ in this respect from those recorded here and most other described forms of this species. The difference is not considered taxonomically significant. The ribbing, however, is variable and Bartenstein and Brand (1937, p. 177) note that in the Middle Dogger of Germany this species appears to be transitional to *Lenticulina tricarinella* (Reuss). In the present material some specimens lack a clearly defined circular rib, and have sharp sutural ribs extending to the periphery. Such specimens are very similar to *L. tricarinella*, but no actual transition was observed, as the forms included here consistently lack the lateral keels of *L. tricarinella*.

This species is common in the English Bathonian, appearing at the base of the Lower Fuller's Earth Clay, which is the earliest recorded occurrence in England.

Lenticulina quenstedti (Reuss) var. A n.var.

Plate 2, figures 9-10

Test large, compressed, with rugose surface; periphery rounded, with distinct keel; chambers numerous, seven or eight visible in the last whorl, increasing in size as added; sutures gently curved, raised along the greater part of their length, and meeting at umbonal area; oblique costae weak and poorly developed near peripheral margin in last part of test; aperture peripheral, radiate, slightly projecting.

The test is larger, and the surface is more rugose than in the typical forms. The circular rib is not as well developed, and oblique costae are generally present in the later chambers, which was not observed in *Lenticulina quenstedti*.

The distribution of this variety appears to be restricted. It was recovered only from the Lower Fuller's Earth Clay at Dorset and at Midford, in the Bath area.

LENTICULINA QUENSTEDTI (Reuss) var. B n.var.

Plate 2, figure 8

Test stout, slightly biconvex, involute, slightly longer than broad; periphery sub-rounded; chambers numerous, six to eight visible in the last whorl, increasing in size as added; sutures curved, strongly limbate, extending from periphery to umbilical area; thin keel, not visible on all specimens; umbilical area depressed, partially filled with beads of calcite, sometimes with partially developed circular rib connecting sutures; aperture radiate, projecting slightly from peripheral margin.

This variety differs from the typical forms in being more involute and robust. The circular rib connecting the sutures is much less developed, and the sutures are generally more limbate.

The variety occurs sporadically throughout much of the Bathonian. It is most common in the *Wattonensis* Beds at Dorset.

LENTICULINA SUBALATA (Reuss)

Plate 2, figures 1-2

Cristellaria subalata Reuss, 1854, p. 68, pl. 25, fig. 13.
Cristellaria casis, Jones and Parker (*non* Fitchel and Moll), 1860, p. 457, pl. 20, fig. 41.
Cristellaria helios Terquem, 1870a, p. 445, pl. 16, figs. 19-21.
Cristellaria subalata, Franke, 1936, p. 115, pl. 11, fig. 19.
Cristellaria (*Lenticulina*) *subalata*, Bartenstein and Brand, 1937, p. 176, pl. 6, fig. 35a-c; pl. 9, fig. 54a-c; pl. 10, fig. 41a-b; pl. 11a, fig. 15a-b; pl. 11b, fig. 22a-b; pl. 12a, fig. 18a-c; pl. 12b; fig. 16; pl. 13, fig. 38a-c; pl. 14b, fig. 16a-b; pl. 15a, fig. 35a-b.
Cristellaria (*Lenticulina*) *subalata* form A Bartenstein and Brand, 1937, p. 177, pl. 9, fig. 55a-f; pl. 10, fig. 42a-b.

This species is similar to *L. munsteri*, but has raised and generally broader sutures. It also resembles *Lenticulina varians* (Borneman), but besides having the raised sutures, is more biconvex and rounder in cross-section than is this latter species.

Specimens of *Cristellaria helios* in the Terquem collection are identical with the present ones. However, other identical specimens in the collection are scattered among various dissimilar species of *Cristellaria* (*sensu lato*) type, some bearing little

resemblance to the figures which are supposed to illustrate them. Consequently, a comprehensive synonymy is difficult.

The type of this species is from the Cretaceous of the eastern Alps, but the Jurassic forms appear to be morphologically identical. It occurs commonly throughout the English Bathonian.

Lenticulina sowerbyi (Schwager)

Cristellaria sowerbyi Schwager, 1867, p. 660, pl. 34, fig. 18.
Cristellaria sowerbyi Deeke, 1886, p. 322, pl. 2, fig. 34.

In some specimens the later chambers overlap on one side, producing a test that is trochoid, and similar to the growth plan that is found in *Darbyella*. The sutures are most generally flush, but they tend to become depressed in the later chambers, a tendency noted in many lagenid species.

Lenticulina tricarinella (Reuss)

Plate 2, figures 20-23

Cristellaria (*Cristellaria*) *tricarinella* Reuss, 1863a, p. 68, pl. 7, fig. 9; pl. 12, figs. 2-4.
Cristellaria polymorpha Terquem, 1870a, p. 454, pl. 19, figs. 1-30; pl. 21, figs. 1-30.
Cristellaria tricarinella, Paalzow, 1917, p. 240, pl. 56, fig. 6.
Cristellaria tricarinella, Klahn, 1921, p. 50, pl. 21, figs. 7-10.
Planularia feifeli Paalzow, 1932, p. 105, pl. 6, figs. 11, 12.
Cristellaria tricarinella, Macfadyen, 1935, p. 15, pl. 1, fig. 18a-b.
Cristellaria (*Astacolus*) *tricarinella*, Bartenstein and Brand, 1937, p. 173, pl. 13, fig. 35a-b; pl. 14b, fig. 13a-b; pl. 15a, fig. 33a-b; pl. 15c, fig. 18.
Cristellaria tricarinella, Frentzen, 1941, p. 353, pl. 5, figs. 13, 14.
Lenticulina (*Planularia*) *tricarinella*, Seibold and Seibold, 1953, p. 54, pl. 4, fig. 5.

This common and distinctive species has been either described or recorded many times from the Jurassic. The sharp, sutural ribs joining the lateral keels are characteristic. Occasionally, the lateral keels are incompletely developed, appearing instead as impersistent costae along the margins of the test. Typically, the tests are tightly coiled, with only one or two chambers extending beyond the spire. In occasional assemblages, however, all degrees of coiling occur, and in some tests the chambers are arranged in linear or curved series, with the spiral part forming

a small, minor portion of the test. Some of the linear types tend to become triangular in cross-section and except for their mutual relationships with the rest of the specimens could be confused with *Saracenaria*.

On some specimens, faint, oblique costae are present between the sutural ribs of the last two chambers. The number and strength of these are very variable, and they most generally occur on those specimens which lack the clearly defined lateral keels.

I have examined a large number of specimens of *Cristellaria polymorpha* Terquem in the Terquem collection, and agree with Macfadyen (1935, p. 15) that this species is a synonym of *Lenticulina tricarinella* (Reuss). The intricate scroll pattern illustrated by Terquem was not observed on any of the specimens. It was observed, however, that when the slides of the Terquem collection were viewed from the underside, irregular streaks in the mounting medium appeared to cover many of the specimens in intricate, scroll-like patterns. Possibly Terquem confused these patterns with ornamentation.

Franke (1936) illustrated a specimen of *Cristellaria polymorpha* Terquem with peculiar markings on the wall which, though less elaborate, are similar to Terquem's scroll-like patterns. His figure otherwise appears to be identical with *Lenticulina tricarinella* (Reuss). The markings may be due to foreign matter on the test, or possibly they may be indistinct, oblique costae.

This species has not been previously described from England. It occurs in the lowermost Fuller's Earth Clay, and the Lower Bathonian is the earliest known English occurrence. This species is a common and characteristic form in the Middle Jurassic of Europe, and Bartenstein and Brand (1937, p. 173) record the earliest occurrence in northwest Germany from the *Parkinsoni* Schichten (Upper Bajocian). If Franke's *Cristellaria polymorpha* (recorded from the Lias Gamma) is a synonym, the range in Germany would extend into the Lower Jurassic. Bartenstein and Brand, however, do not consider Franke's form a synonym.

Lenticulina tricarinella (Reuss) var. A n.var.

Plate 2, figure 24

Test small, compressed, finely perforate, incompletely coiled, three to five chambers arranged in gently curved series, increasing in size as added; keel single, well developed, extending without interruption over entire peripheral margin; striae absent or faintly developed in last chambers; sutures raised in sharp ridges, connecting with keel; aperture radiate.

This variety lacks the marginal keel and is generally smaller than typical members of the species. It occurs rarely in the Upper Fuller's Earth Clay and *Wattonensis* Beds of the Dorset Coast.

Lenticulina turgida (Schwager)

Plate 2, figures 18-19

Cristellaria turgida Schwager, 1865, p. 127, pl. 6, fig. 4.
Cristellaria informis Schwager, 1865, p. 128, pl. 6, fig. 8.
Cristellaria inflata, Wisniowski (*non* Schwager), 1890, p. 227, pl. 10, fig. 13a-b.
Lenticulina (*Astacolus*) *matutina informis*, Seibold and Seibold, 1956, p. 119, pl. 7, fig. 13; text fig. 4e-g.

There is one microsphere in the present material, and the specimen is larger than the others. It consists of eight chambers, and the last one overlaps on one side, as in *Darbyella*.

There is good agreement between specimens included here and the figures of Seibold and Seibold who studied topotype material from which Schwager originally described the species. The English Bathonian forms, however, show less tendency to uncoil.

Lenticulina varians (Borneman)

Plate 2, figures 11-13

Cristellaria varians Borneman, 1854, p. 41, pl. 4, figs. 32-34.
Cristellaria inquisita Terquem, 1870a, p. 444, pl. 16, figs. 16-18.
Cristellaria (*Lenticulina*) *varians* Borneman var. *recta* Franke, 1936, p. 113, pl. 11, fig. 12.
Cristellaria (*Lenticulina*) *varians*, Bartenstein and Brand, 1937, p. 176, pl. 1a, fig. 18; pl. 2a, figs. 16, 20; pl. 3, fig. 31; pl. 5, fig. 60; pl. 8, fig. 53a-b.

Cristellaria (*Lenticulina*) *varians* form A Bartenstein and Brand, 1937, p. 176, pl. 10, fig. 40a-d; pl. 11a, fig. 14a-d; pl. 11b, fig. 21a-b.

This species most closely resembles *Lenticulina munsteri* (Roemer), and is distinguished by the more compressed nature of the test and the narrower, slightly depressed sutures.

Borneman's figures are not too clear, nor do they indicate the possible variation of this species. Consequently, various interpretations are possible and there are a variety of forms in the literature bearing this name, many of which are distinct from those included here. Synonymies are uncertain and the types need to be re-studied.

Terquem showed only outline drawings of *Cristellaria inquisita,* but the specimens in the Terquem collection are identical with the ones recorded here.

Genus PLANULARIA Defrance, 1824

PLANULARIA ANCEPS (Terquem)

Plate 3, figures 14-15

Cristellaria anceps Terquem, 1870a, p. 428, pl. 9, figs. 11-21.
Cristellaria dolium Terquem, 1870a, p. 431, pl. 9, fig. 29a-b.

There is one microsphere in the present material, and it is identical with the megalospheres, except that the large proloculus is represented by several small chambers which form an incomplete coil.

Terquem illustrated a variety of specimens of this species, including forms with depressed sutures and a globular proloculus. He later extended the species (Terquem, 1883, p. 350, pl. 38, figs. 18-28; pl. 39, figs. 1-2) to include a variety of forms which bear very little resemblance to the earlier figures. Many of the later figures seem to represent aberrant or immature specimens, and probably belong to other species. Even as originally described, the species probably consists largely of an unrelated group of specimens. However, there is good agreement between my specimens and some of Terquem's figures (particularly pl. 9, fig. 12), as well as the specimens from the Terquem collection, so that there is at least partial identity.

Planularia beierana (Gumbel)

Plate 3, figures 1-10; text figure 3.

Marginulina beierana Gumbel, 1862, p. 221, pl. 3, fig. 20a-b.
Cristellaria jurassica Gumbel, 1862, p. 224, pl. 3, fig. 25a-c.
Cristellaria semiinvoluta Terquem, 1870a, p. 435, pl. 11, figs. 1-30; pl. 12, figs. 1-30.
Cristellaria suturalis Terquem, 1870a (*non* Terquem, 1866a), p. 434, pl. 10, figs. 19-24.
Cristellaria semiinvoluta var. *plana* Deecke, 1886, p. 317, pl. 2, fig. 35.
Planularia semiinvoluta, Paalzow, 1932, p. 105, pl. 6, figs. 13, 14, 20, 21.
Cristellaria (*Planularia*) *cordiformis*, Bartenstein and Brand (*non* Terquem), 1937, p. 169, pl. 6, fig. 30a-b; pl. 9, fig. 43a-e; pl. 10, fig. 30a-d; pl. 12a, fig. 10; pl. 12b, fig. 11a-b; pl. 13, fig. 29a-c; pl. 14b, fig. 10; pl. 15a, fig. 28a-b.
Cristellaria (*Planularia*) *crepidula*, Bartenstein and Brand (*non* Fitchel and Moll), 1937, p. 169, pl. 2a, fig. 18a-b; pl. 3, fig. 48; pl. 4, fig. 76; pl. 5, fig. 74; pl. 9, fig. 45a-e; pl. 10, fig. 31; pl. 11a, fig. 11; pl. 11b, fig. 16a-b; pl. 12a, fig. 12a-d; pl. 12b, fig. 12a-b; pl. 13, fig. 31; pl. 14b, fig. 11; pl. 14c, fig. 12; pl. 15a, fig. 30; pl. 15c, fig. 15a-b.
Cristellaria (*Planularia*) *filosa*, Bartenstein and Brand (*non* Terquem), 1937, p. 169, pl. 4, fig. 77; pl. 9, fig. 44; pl. 11a, fig. 15a-b; pl. 12a, fig. 11; pl. 13, fig. 31; pl. 15a, fig. 29a-c, pl. 15c, fig. 14a-b.
Lenticulina (*Planularia*) *cordiformis*, Bartenstein, 1948, pl. 2, figs. 13-15.
Lenticulina (*Planularia*) *crepidula*, Bartenstein, 1948, pl. 2, figs. 20-21.
Falsopalmula deslongchampsi, Bartenstein (*non* Terquem), 1948, pl. 1, figs. 6-7; pl. 2, fig. 10.
Falsopalmula obliqua, Bartenstein (*non* Terquem), 1948, pl. 2, figs. 11-12.
Lenticulina (*Planularia*) *beierana*, Seibold and Seibold, 1955, pl. 13, fig. 7; text fig. 4e, f.

Test small, much compressed, with thin, transparent wall; chambers, numerous, five to eleven in number, first four or five arranged in a loose coil, remainder arranged in a linear or gently curved series, last ones sometimes equitant; proloculus in megalosphere large, suboval, generally subparallel to longitudinal axis of test; sutures flush, depressed or sometimes raised in form of marginal ribs; aperture terminal, radiate.

Microspheres are rare, occurring in about one out of eight specimens. They do not differ from the megalospheres, except that the proloculus is smaller, and there are a greater number of chambers. The size of the proloculus is quite variable, but is always large in relation to the size of the test. There is no

evidence to suggest trimorphism within this species, as the proloeular size differences are transitional among the megalospheres.

The shape of the test is highly variable, and is related to the degree of overlap of the chambers on the proloeular area. This relationship has been previously described in *Planularia pauperata* Jones and Parker by Barnard (1950b, p. 11).

The raised sutures were observed only on specimens from the *Wattonensis* Beds, where this species exhibits an extremely high degree of variability. All gradations from depressed to flush, to limbate, can be observed. Not only is this character variable from specimen to specimen, but in a single individual all three types of suture may be found.

The transitional nature of the typical uncoiled growth plan to the equitant or flabelline chamber form is illustrated in Figure 3A-N. All specimens were recovered from a single sample from the *Wattonensis* Beds on the Dorset Coast. The equitant chambers vary in number, size and degree of symmetry, reflecting a high instability of the character. In some instances the change in growth plan is marked (Figure 3I), while in others it is accomplished gradually, by progressive overlap of the later chambers on the oral margin (Figure 3G). Growth is sometimes irregular, and in Figure 3K the ninth chamber partially reverts to the linear arrangement by failing to overlap on the oral margin. In Figure 3N the equitant chambers have developed before the test has uncoiled, and the longitudinal axis of the test is shifted towards the adoral margin. This specimen is also unusual in that the proloculus is elongated in a direction approximately perpendicular to the longitudinal axis of the test, contrary to other specimens in which the proloculus is elongate parallel to the long axis of the test.

This species is highly variable in almost all observable morphological characters, and the problem of deciding which specific name to use is difficult. All of the diverse types illustrated here are connected by integrading forms, and there appears to be no logical way of separating them on the basis of morphology or distribution. They are therefore regarded here as a single, highly variable species. I have examined topotypes of *Planularia beierana*, and there is good agreement with these specimens.

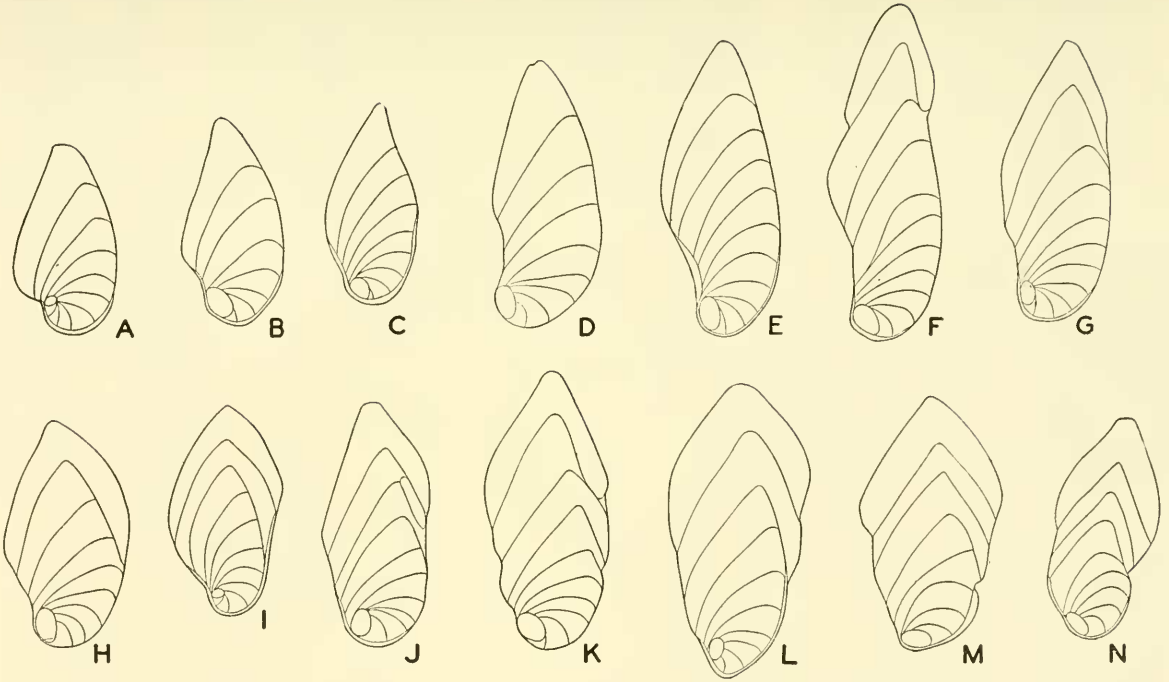

Figure 3. Variation of *Planularia beierana* (Gumbel). All specimens are from sample DoEm4, *Wattonensis* Beds, Dorset.

except that the topotypes tend to be broader, and the later chambers generally overlap more on the proloeular area. They may possibly form a link with *Planularia pauperata* Jones and Parker. The specimens of *Planularia pauperata* from Chelaston, Derby, in the Jones and Parker collection at the British Museum (Natural History) appear to be distinct from the present ones. They are generally more robust, broader, and the chambers show more overlap. There are only three specimens in the collection, and possibly a more numerous suite would show transitions to the present ones. However, the specimens of *P. pauperata* from the Lias of Byfield described by Barnard (1950b, p. 10, pl. 2, fig. 7) are identical with those from Chelaston, Derby, and are distinct from the Bathonian forms.

Cristellaria semiinvoluta Terquem appears to represent a heterogeneous group of specimens. Unfortunately, many of the specimens of this species in the Terquem collection do not agree well with the figures that presumably illustrate them, and without the original types it is not possible to properly analyze this species. There is no doubt, however, that in part, at least, this species is a synonym of *Planularia beierana*. The striate forms do not seem to belong here, but this cannot be determined until the types have been recovered, or the type locality re-examined. The large number of forms illustrated by Bartenstein and Brand (and included here in this species) do not appear distinct to me, even on the basis of those authors' material. The variational patterns of *P. beierana* in northwest Germany are similar to the ones encountered in the English Bathonian. However, the form described as *Cristellaria* (*Planularia*) *cordiformis* Terquem may possibly be transitional to *P. pauperata*. Forms identical with the ones described by Bartenstein as *Falsopalmula deslongchampsi* (Terquem) and *Falsopalmula obliqua* (Terquem), are included here because of the transitional nature and intimate association of these identical forms with typical forms of *Planularia beierana*, in the English Bathonian.

This species is common in the English Bathonian, and individuals are generally numerous. The variational patterns are sporadic, but by far the greatest "bursts" occur in the *Wattonensis* Beds at Dorset. Here the sutures show all gradations from distinctly depressed to rather prominent marginal ribs. The

shapes are highly variable, and equitant chambers are more common than at any other locality. Equitant chambers were also observed in specimens from the Lower Fuller's Earth Clay at Dorset and Midford, and from the Bradford Clay in the Monk quarry at Corsham.

Planularia breoni (Terquem)

Plate 3, figure 11

Cristellaria breoni Terquem, 1864a, p. 420, pl. 9, figs. 4a, b.
Cristellaria (*Astacolus*) *breoni*, Bartenstein and Brand, 1937, p. 173, pl. 4, fig. 75; pl. 5, fig. 56.
Cristellaria (*Astacolus*) *radiata*, Bartenstein and Brand (*non* Terquem), 1937, p. 172, pl. 5, fig. 58; pl. 12b, figs. 14a-c; pl. 13, figs. 34a-b.
Cristellaria (*Astacolus*) *quadricostata*, Bartenstein and Brand (*non* Terquem), 1937, p. 173, pl. 3, fig. 47; pl. 4, fig. 71; pl. 5, fig. 57.

This species resembles *Planularia eugenii* (Terquem) in its numerous striations which completely cover the sides of the test. However, *P. breoni* is more rounded in cross-section, has broader chambers and the sutures are more depressed.

Planularia eugenii (Terquem)

Plate 3, figures 16-17

Cristellaria eugenii Terquem, 1864a, p. 414, pl. 9, fig. 16a-b.
Cristellaria arietis Issler, 1908, p. 81, pl. 5, figs. 255-260.
Cristellaria crepidula (Fitchel and Moll) var. *striata* Issler, 1908, p. 82, pl. 5, figs. 255-266; pl. 6, figs. 266-268.
Cristellaria (*Planularia*) *eugenii*, Bartenstein and Brand, 1937, p. 170, pl. 3, fig. 56; pl. 10, fig. 33a-b; pl. 12a, fig. 13.

One microsphere was observed, and it differed from the megalospheres only in the greater number of chambers in the coiled portion of the test. The species is highly variable in shape, with specimens ranging from elongate with parallel margins, to broad, stubby ones in which the margins diverge. The number of ribs range from ten to twenty and in strength from faint striations to prominent ribs.

This species is similar to *Planularia beierana* (Gumbel), but is distinguished by the presence of ribs and the shape of the chambers which are much lower in relation to the breadth than in the latter species.

Terquem described this species from the Lias. The one specimen available from the Terquem Lias collection in the Muséum d'Histoire Naturelle is much larger and more robust than the present ones, but otherwise they compare well, and I consider them identical. Terquem included many striate forms in *Cristellaria semiinvoluta* and *Cristellaria subinvoluta* and possibly many of these belong here as well.

Planularia inconstans (Schwager)

Cristellaria inconstans Schwager, 1867, p. 658, pl. 34, fig. 15.
Cristellaria dialatata Wisniowski, 1890, p. 211, pl. 9, fig. 10.
Cristellaria dorsoarcuata Wisniowski, 1890, p. 211, pl. 9, fig. 11.
Cristellaria (*Astacolus*) *inconstans*, Bartenstein and Brand, 1937, p. 171; pl. 10, fig. 34a-c.

This species resembles *Planularia protracta* (Borneman), but can be distinguished by the broader, lower chambers and the absence of a coil.

Specimens are rare and were recovered only from the *Wattonensis* Beds.

Material deposited at M.C.Z. No. 3333.

Planularia protracta (Borneman)

Plate 3, figures 12-13

Cristellaria protracta Borneman, 1854, p. 39, pl. 4, fig. 27a-b.
Cristellaria lista Borneman, 1854, p. 39, pl. 4, fig. 28.
Cristellaria protracta, Macfadyen, 1941, p. 32, pl. 2, fig. 24.

This species is similar to *Planularia beierana* (Gumbel), but is distinguishable by the more oval, less compressed test and by the much greater curvature of the peripheral margin at the base of the test.

Planularia sp. A

Test compressed, slightly twisted; thin walled, transparent; chambers numerous, the first three forming incomplete coil, the remaining four arranged in a linear series, increasing regularly and rapidly in height as added, moderately in breadth; sutures depressed, particularly in later chambers; aperture terminal, radiate.

The specimens are similar in outline to *Planularia pauperata* Jones and Parker, but the test is twisted, and the last chambers tend to be bulbous. The material consists of three specimens from three separate localities in the Upper Fuller's Earth Clay.

Material deposited at M.C.Z. No. 3335.

Planularia sp. B

Plate 3, figure 18

Several poorly preserved specimens are included here which consist of linear tests with low, broad chambers, arched in the early portion, but not actually coiled. The sutures are depressed and slightly curved. The shapes vary from broad, short forms, to long, slim ones. The most distinctive feature is the presence of an elevated border on both margins of the test, against which the sutures abut. This feature is characteristic of *Planularia arguta* Reuss, a Cretaceous form. The present specimens are similar to fragments identified as this species and described by Blake (1876, p. 464, pl. 19, fig. 10), from the Lias of Yorkshire. The Bathonian material, however, is poorly preserved, and the raised margins, which are not present on all of the specimens, may be due to squashing in the central portions of the tests.

The forms resemble *Vaginulina legumen* (Linné), but are smaller and flatter; in side view they tend to be more triangular.

The specimens are rare, and occur only in the Cotswolds, Oxford and Northampton areas.

Genus MARGINULINA d'Orbigny, 1826

Marginulina deslongchampsi Terquem

Plate 3, figure 21

Marginulina deslongchampsi Terquem, 1864a, p. 188, pl. 8, fig. 8a-b.
Marginulina oolithica, Franke (*non* Terquem), 1936, p. 74, pl. 7, fig. 17a-b.
Marginulina oolithica, Bartenstein and Brand, 1937, p. 160, pl. 2a, fig. 11; pl. 2b, fig. 27; pl. 3, fig. 38; pl. 6, figs. 17, 26; pl. 8, fig. 26a-b; pl. 10, fig. 24.

Specimens from the English Bathonian are somewhat less curved in the initial portion of the test than are shown in the figures of Terquem, but are still distinctly marginuline, and otherwise agree well with the figures.

The shape of the chambers is variable and in some specimens the chambers are bulbous and twisted slightly from the longitudinal axis. The degree of curvature is also variable, and some tests are almost dentaline.

This species is rare, and occurs only in the Lower Fuller's Earth Clay and *Wattonensis* Beds on the Dorset Coast.

Marginulina terquemi d'Orbigny

Plate 3, figures 19-20

Marginulina terquemi, Terquem (*non* d'Orbigny), 1858, p. 609, pl. 3, fig. 1a-c.

Marginulina glabra, Haeusler (*non* d'Orbigny), 1890, p. 106, pl. 14, figs. 35-40, 42-43.

Marginulina glabra, Bartenstein and Brand, 1937, p. 160, pl. 10, fig. 25a-b; pl. 11b, fig. 11; pl. 13, fig. 16a-b.

Specimens included here vary considerably in the height of the coil, and the shape of the cross-section. The chambers are less bulbous and the tests are slimmer than in Terquem's figures, but are otherwise identical.

This species is very similar to *Marginulina glabra* d'Orbigny, which is a Recent form, and perhaps identical.

Genus DENTALINA d'Orbigny, 1826

Dentalina bicornis Terquem

Plate 4, figure 7

Dentalina bicornis Terquem, 1870b (pars), p. 370, pl. 29, figs. 13-16 (*non* fig. 17).

Dentalina bicornis, Bartenstein and Brand, 1937, p. 138, pl. 10, fig. 17a-c; pl. 15a, fig. 8.

Dentalina bicornis, Seibold and Seibold, 1953, p. 59, pl. 4, fig. 15; pl. 5, fig. 17.

This species is rare, and was observed only in the Kemble Beds at Oxfordshire.

Dentalina communis d'Orbigny

Plate 4, figure 11

Dentalina communis d'Orbigny, 1826, p. 254, no. 35.

Dentalina pseudocommunis Franke, 1936, p. 30, pl. 2, fig. 20a-b.

Dentalina ventricosa Franke, 1936, p. 33, pl. 3, fig. 1a-b.
Dentalina communis, Bartenstein and Brand, 1937, p. 136, pl. 1a, fig. 6; pl. 1b, figs. 14-15; pl. 2a, fig. 5; pl. 2b, figs. 9-10; pl. 3, fig. 8; pl. 4, fig. 23a-b; pl. 5, fig. 13; pl. 6, fig. 10.
Dentalina ventricosa, Bartenstein and Brand, 1937, p. 140, pl. 4, fig. 20; pl. 5, fig. 15.
Dentalina communis, Macfadyen, 1941, p. 39, pl. 2, fig. 34.
Dentalina pseudocommunis, Barnard, 1950b, p. 19, pl. 3, figs. 6, 7.

This species was originally described from Recent sediments of the Mediterranean, and there is much disagreement about the systematic position of the Jurassic forms. Macfadyen studied Recent forms from the Mediterranean and concluded that those from the Jurassic are identical. Barnard found the Jurassic forms to be highly variable, and referred his specimens to *D. pseudocommunis* Franke, as he felt it unlikely that such a variable species could have such a long range in time. Brotzen (1953, p. 35) does not believe that the Jurassic forms are closely related to the modern ones, suggesting that they may not even belong to the genus *Dentalina*. I agree with Macfadyen, and can see no morphological distinction between the Recent and the Jurassic forms. It is possible that *D. communis* is a morphological type of polyphyletic origin occurring in Mesozoic and Cenozoic strata, but the lineages have yet to be demonstrated.

Material deposited at M.C.Z. No. 3340B.

Dentalina aff. D. communis d'Orbigny

Plate 4, figures 14-15

Test small, arched, oval in cross-section, with four to six chambers, higher than wide, increasing in size as added, early ones irregular in shape, last ones much larger than preceding and bulbous; sutures depressed, only slightly oblique; proloculus small, spherical; aperture central, radiate.

These specimens are similar to *Dentalina communis* d'Orbigny but differ in their smaller size, less oblique sutures and more central position of the aperture. In addition, the early chambers are characterized by irregular growth, and the shape and size of these are very variable.

The relationships of this form are uncertain, and the resemblances with *D. communis* are probably superficial. The specimens recorded here appear to belong to a distinct species, but

they are rare, occurring less than three to a sample, so that they cannot be adequately described.

The distribution is of some interest. Although specimens are rare they occur at a number of localities in the Upper Fuller's Earth Clay, Bradford Clay and Forest Marble on the Dorset Coast and the Bath area. They have not been recovered from lower horizons.

Dentalina conferta Schwager

Plate 4, figure 3

Dentalina conferta Schwager, 1865, p. 106, pl. 3, fig. 9.
Dentalina bullata Schwager, 1865, p. 107, pl. 3, fig. 23.
Dentalina brevis. Issler (*non* d'Orbigny), 1908, p. 63, pl. 3, figs. 150-154.
Dentalina linearis, Issler (*non* Roemer), 1908, p. 64, pl. 3, fig. 155.
Dentalina suboligostegia Franke, 1936, p. 25, pl. 2, fig. 1.
Dentalina numismalis Franke, 1936, p. 25, pl. 2, fig. 4.
Dentalina bullata, Seibold and Seibold, 1956, p. 128, pl. 7, fig. 3; text fig. 6a-b.
Dentalina conferta, Seibold and Seibold, 1956, p. 129, pl. 7, fig. 14; text fig. 5y.

This species is rare, and occurs only in the *Wattonensis* Beds at the Dorset Coast.

Dentalina intorta Terquem

Plate 4, figures 16-19

Dentalina intorta Terquem, 1870b, p. 364, pl. 27, figs. 26-34.
Dentalina ventricosa, Bartenstein and Brand (*non* Franke), 1937, p. 140, pl. 4, fig. 20; pl. 5, fig. 15.
Dentalina lateralis, Bartenstein and Brand (*non* Terquem), 1937, p. 135, pl. 5, fig. 16a-b.

This species is highly variable in shape and size of the test. Most of the specimens are short and broad, but these grade into individuals that are long and slim. The proloculus varies in shape from globular, equidimensional types to long, narrow ones. In all specimens observed the proloculus is large, and no microspheres were recognized. The later chambers tend to become bulbous and overlap the preceding ones on the convex side. In some specimens the axis of the last chambers tends to rotate from

the axis of the preceding ones, sometimes as much as ninety degrees. This results in a plan of growth that is similar to species included with the Polymorphinidae.

These specimens are identical with those figured by Terquem and the specimens in the Terquem collection in Paris. One of the specimens in the collection shows a shift on the axis of the last chamber from the preceding ones, such as has been described above.

This species is common in the English Bathonian. In northwest Germany, identical forms described by Bartenstein and Brand are recorded from the Lias.

Dentalina mucronata Neugeboren

Plate 4, figures 1-2; text-figure 4

Dentalina mucronata Neugeboren, 1856, *in* Ellis and Messina, *Catalogue of Foraminifera.*

Dentalina cornuformis Terquem, 1870b, p. 367, pl. 28, fig. 16.

Dentalina turgida, Wisniowski (*non* Schwager), 1890, p. 201, pl. 1, fig. 48.

Dentalina mucronata, Bartenstein and Brand, 1937, p. 138, pl. 10, fig. 16; pl. 11b, fig. 5a-b; pl. 12b, fig. 4a-b.

The shape of the test is highly variable. Most individuals are moderately broad, but some are long and slender while others are stout. Some of the broad forms are slightly arched at the base and have low, broad proloculi. Such specimens are morphologically indistinguishable from *Vaginulina legumen* (Linné), and can be identified only by their association with transitional and more typical forms in a single assemblage. The variation and resemblance of "end forms" to *Vaginulina legumen* is illustrated in Figure 4.

A similar form is *Dentalina communis* d'Orbigny, but in this latter species the margins are smooth and the chambers are not inflated.

This species was originally described from the Tertiary of the Vienna Basin. The Bathonian forms compare well with Neugeboren's figures, but specimens from the Tertiary were not examined. Specimens of *Dentalina cornuformis* from the Terquem collection in Paris are identical with those recorded here.

This species is fairly common in the English Bathonian, particularly in the Upper Fuller's Earth Clay of the Dorset Coast.

Material deposited at M.C.Z. Nos. 3344C, 3344D.

Dentalina nodigera Terquem and Berthelin
Plate 4, figure 8

Dentalina nodigera Terquem and Berthelin, 1875 (pars), p. 25, pl. 1, fig. 31a only.

Dentalina nodigera, Franke, 1936, p. 26, pl. 2, fig. 7a-b.

Specimens are rare, and consist only of fragments. The tests are thin, transparent and composed of pyriform chambers which are inflated on one side and compressed on the other. The sutures are depressed and the last chambers have rather long necks with bulbous accumulations of calcite on the ends. The apertures are somewhat indistinct, but appear to be rounded.

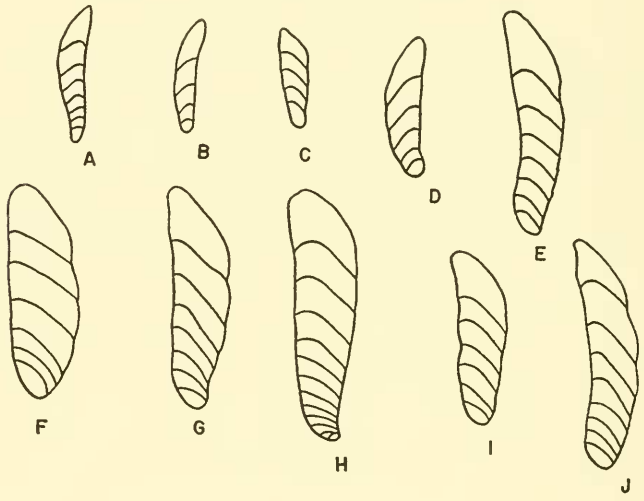

Figure 4. Variation of *Dentalina mucronata* (Neugeboren) and *Vaginulina legumen* (Linné), showing similarity of end forms in the two species.

Dentalina oolithica Terquem
Plate 4, figure 10

Dentalina oolithica Terquem, 1870b, (pars), p. 366, pl. 28, figs. 5-6 only.
Dentalina plebeia Terquem 1870b (pars), p. 369, pl. 29, figs. 3-6 only.

Terquem included a variety of forms in this species. The present specimens agree well with those in the Terquem collection and with the illustrations cited above. The remaining figures are possibly illustrations of variants of other species, but the drawings appear schematic and unlike anything I have encountered in the English Bathonian.

This species occurs throughout the English Bathonian, and is particularly common in the Upper Fuller's Earth Clay.

Dentalina propinqua Terquem

Plate 4, figures 4-6

non Dentalina jurensis Gumbel, 1862, p. 220, pl. 3, figs. 14a-c.
Dentalina jurensis Terquem, 1870b, p. 362, pl. 27, figs. 6-16.
Dentalina propinqua Terquem, 1870b, p. 365, pl. 28, figs. 1-2.
Dentalina sinemuriensis, Bartenstein and Brand (*non* Terquem), 1937, p. 139, pl. 1a, fig. 8; pl. 2b, fig. 12; pl. 4, fig. 21; pl. 5, fig. 19; pl. 6, fig. 12; pl. 8, fig. 11a-c.
Dentalina arbuscula, Bartenstein and Brand (*non* Terquem), 1937, p. 139, pl. 1a, fig. 7; pl. 2b, fig. 12; pl. 3, fig. 11; pl. 4, fig. 19; pl. 5, fig. 18.
non Dentalina jurensis, Seibold and Seibold, 1955, p. 112, pl. 13, fig. 9; text fig. 2n.

This species is intermediate in structure between *Dentalina* and *Nodosaria*. Most of the tests are arcuate, but some are straight and the sutures are transverse. There is much variation in the sutures, which are normally depressed, resulting in constriction of the chambers along the margins. Such forms, however, grade into those having perfectly flush sutures and smooth margins. The size of the aperture is also variable. Where there is little constriction of the final chamber it is large, but where the chamber is much constricted the aperture is narrow and typically dentaline. The aperture is only faintly radiate, and in some specimens may be rounded.

The name *Dentalina jurensis* by which Terquem designated this species was preoccupied by *D. jurensis* of Gumbel, as pointed out by Seibold and Seibold (1955, p. 113). However, *D. propinqua* appears to be identical with it, so that that name is used here to designate Terquem's species.

This species occurs throughout most of the Bathonian, but is most common in the Upper Fuller's Earth Clay.

Dentalina subplana Terquem

Plate 4, figures 12-13

Dentalina subplana Terquem, 1870b (pars), p. 367, pl. 28, figs. 19, 20, 22 only.

Dentalina punguinculus, Bruckman (*non* Reuss), 1904, p. 28, pl. 3, figs. 29-31.

This species is similar to *Dentalina terquemi* d'Orbigny, and is probably closely related. It differs from the latter in the smaller size of the test, the more oblique sutures, and the lack of bulbous chambers in the last part of the test. *D. terquemi* appears to be restricted to the Lias in both England and northwest Germany. Forms comparable to *D. subplana* have not been recorded from northwest Germany. Another similar form is *D. vetustissima* d'Orbigny as described by Bartenstein and Brand (1937, p. 137, pl. 4, fig. 25; pl. 5, fig. 12). This latter species is more apiculate, and the chambers are less drum-like than in the present specimens. *D. vetustissima* was recorded from the Lias only, by Bartenstein and Brand.

The forms recorded here compare well with the figures cited, and with the specimens in the Terquem collection.

This species is common only in the *Wattonensis* Beds of the Dorset Coast, but also occurs in the Lower Fuller's Earth Clay of the Dorset Coast, the Fuller's Earth Rock, and the Bradford Clay of the Bath area.

Dentalina torta Terquem

Plate 4, figure 9

Dentalina torta Terquem, 1858, p. 599, pl. 2, fig. 6a-b.

Dentalina torta, Franke, 1936, p. 27, pl. 2, fig. 9.

Dentalina torta, Bartenstein and Brand, 1937, pl. 3, fig. 9; pl. 4, fig. 24; pl. 5, fig. 14; pl. 10, fig. 11.

Dentalina varians, Bartenstein and Brand (*non* Terquem), 1937 (pars), p. 135, pl. 10, fig. 14; pl. 12b, fig. 3.

Dentalina ensis, Bartenstein and Brand (*non* Wisniowski), 1937, pl. 8, fig. 9a-b.

This species is similar to *Dentalina intorta* Terquem with which it may possibly intergrade. However, the tests of the specimens included here are larger and not as compressed as

those of the latter species, but the sutures are more depressed, resulting in more bulbous chambers.

The English Bathonian forms differ somewhat from Terquem's figure, which illustrates a much more tapered test with less bulbous chambers and a proloculus which is much smaller than any observed in my material. The differences are minor, however, and these specimens are considered identical.

Genus NODOSARIA Lamarck, 1812

Nodosaria clavula (Terquem)

Plate 4, figure 20

Dentalina clavula Terquem, 1870b, p. 366, pl. 28, fig. 4.

These specimens compare well with Terquem's figure, except that they do not show the depressed sutures, indicated in Terquem's figure.

This species is very rare, and was discovered only from the Forest Marble on the Dorset Coast.

Nodosaria hortensis Terquem

Plate 4, figures 22-24

Nodosaria hortensis Terquem 1866b, p. 476, pl. 19, fig. 13.
Nodosaria fontinensis Terquem 1870b, p. 353, pl. 26, figs. 1-5.
Nodosaria variablis Terquem 1870b, p. 353, pl. 26, figs. 6-12.
Nodosaria mutablis Terquem and Berthelin 1875, p. 20, pl. 1, fig. 19a-b.
Nodosaria hortensis, Macfadyen, 1941, p. 43, pl. 3, fig. 41a-b.
Nodosaria hortensis, Barnard, 1950b, p. 19, pl. 3, fig. 3.

An exhaustive synonymy of this species has been provided by Macfadyen (1941, p. 43). In their remarks on *Nodosaria fontinensis* (a synonym) Bartenstein and Brand (1937, p. 148) noted that the Dogger specimens tend to have finer, less sharp costae than those from the Lias. A comparison of the present material with that of the Lias of Byfield described by Barnard reveals similar differences.

Nodosaria ingens (Terquem)

Plate 4, figure 25

Dentalina ingens Terquem 1870b, p. 361, pl. 27, fig. 5.
Nodosaria guttifera, Bartenstein and Brand (*non* d'Orbigny), 1937, p. 144, pl. 13, fig. 7.

The material consists of a few fragments composed of two or three bulbous chambers connected by long necks. The apertures are radiate.

A similar species is *Dentalina guttifera* d'Orbigny, which is a Tertiary form, originally described from the Vienna Basin. In the present species, however, the chambers are more inflated and tapered less towards the apertural neck.

Nodosaria aff. N. issleri Franke

Plate 4, figures 36-37

Test small, slightly tapered, composed of four to six chambers increasing in height and breadth as added; sutures depressed, transverse; growth somewhat irregular in early stages, resulting sometimes in slightly arched test; last chamber considerably larger than preceding and flaring; surface ornamented with ten fine ribs extending continuously from base of proloculus to end of last chamber; proloculus small, rounded; aperture terminal, rounded, situated on a short neck.

The English Bathonian forms are similar to *Nodosaria issleri* Franke, and differ only in the greater persistence of the ribs which extend up to the end of the apertural neck. Paratypes of *Nodosaria isslcri* were examined at the Senckenberg Museum, Frankfurt a.M., and the present specimens are undoubtedly closely related to this species. Another similar and probably related form is that figured by Issler (1908, p. 52, figs. 73-78) as *Nodosaria raphanus* (Linné) which lacks the apertural neck, but is otherwise indistinguishable.

Nodosaria liassica Barnard

Plate 4, figure 33

Nodosaria obscura, Bartenstein and Brand (*non* Reuss), 1937, p. 147, pl. 8, fig. 18.

Nodosaria obscura var. *liassica* Barnard, 1950b, p. 18, text fig. 10.

A few specimens are identical with those described by Barnard from the Upper Lias of Byfield. The Jurassic forms are treated here as a separate species, since Reuss's figure of *N. obscura* is not clear and the relationship with the Cretaceous form is uncertain.

This species is rare, and was observed only in the Lower Fuller's Earth Clay of the Dorset Coast.

Nodosaria opalini Bartenstein

Plate 4, figures 26-31

Nodosaria opalini Bartenstein and Brand, 1937, p. 147, pl. 8, fig. 13a-b; pl. 10, fig. 18a-b.

This species exhibits much variation in the amount of sutural depression and in the strength of the costae. In many specimens the sutures are flush, and the chambers show no constriction. In others, the sutures in the later portion of the test are depressed, and the last chambers are constricted. Some specimens have constricted chambers throughout the length of the test. Costae vary from strong, well defined ribs, to faint, barely perceptible striations. They are, however, always present and are numerous.

This species is widely distributed throughout the English Bathonian, and is particularly common in the Upper Fuller's Earth Clay. There are no previous records of it in England. In Germany it has been recorded from the Dogger Alpha (Lower Bajocian) by Bartenstein and Brand.

Nodosaria pectinata (Terquem)

Plate 4, figures 34-35

Dentalina pectinata Terquem, 1870b, p. 360, pl. 26, figs. 26-30.

The material consists of fragments composed of three or four chambers. Although the tests are distinctly arched, the transverse sutures and centrally located apertures suggest that the specimens are better placed in *Nodosaria* than *Dentalina*.

The specimens have been compared with those in the Terquem collection and are identical.

Nodosaria plicatilis Wisniowski

Plate 4, figure 21

Nodosaria plicatilis Wisniowski, 1890, p. 194, pl. 1, fig. 16.
Nodosaria plicatilis, Paalzow, 1922, p. 16, pl. 2, fig. 4.
Nodosaria plicatilis, Bartenstein and Brand, 1937, p. 149, pl. 15a, fig. 14.

This species resembles *N. hortensis* in its ornamentation and in its general shape. The two species often occur together, but *N. plicatilis* is distinguished by being more oval in cross-section, with fewer costae.

Nodosaria aff. N. prima d'Orbigny

Plate 4, figure 32

Test straight or slightly arched, tapered; chambers numerous, generally seven or eight composing the test, increasing in size as added, but occasional chamber smaller than previous, longer than broad, only slightly inflated; proloculus large, spherical; surface covered with about fourteen prominent costae extending continuously from tip of proloculus to tip of aperture; aperture terminal, radiate, generally centrally located, but sometimes shifted towards margin; sutures transverse or very slightly oblique, depressed.

The shift of the aperture from the center to the margin in some specimens, as well as the occasional curvature of the test is reminiscent of *Dentalina*, and this form is somewhat intermediate in structure.

These specimens are similar to the types of *N. prima* as refigured by Macfadyen, but these illustrations do not show the curvature of the test or the shift of the aperture towards the margin. This species resembles *N. hortensis*, but has a radiate aperture in addition to more numerous and persistent costae.

Nodosaria sp. A

Plate 4, figure 38

The material consists of a single, tiny specimen which is very slender and is composed of three chambers. The sutures are flush, so that the outline of the test is smooth. The chambers are almost twice as high as broad, with the center one being the longest. There is no visible ornamentation and the aperture is central and radiate.

The specimen resembles *N. pyriformis* Terquem figured by Macfadyen (1941, p. 46, pl. 3, fig. 44), but the chambers are not as pyriform. It is also similar to *N. pyrula* d'Orbigny as figured

by Haeusler (1890, p. 28, pl. 5, figs. 25-26), but is a much slimmer test and has fewer chambers. The single specimen occurs in the Sharp's Hill Beds, Oxfordshire.

Nodosaria sp. B

Plate 4, figure 39

The material consists of several fragments composed of four or five chambers arranged in a straight series, with the first chambers broader than long, and the later ones longer than broad. The surface is covered with numerous, fine costae which are barely perceptible. The sutures are transverse, with the earlier chambers impressed on the later ones. The aperture is central and rounded.

These specimens are similar to *N. pectinata* (Terquem), but are much smaller, and have much fainter costae. The impressed sutures have not been observed on *N. pectinata*.

Genus TRISTIX Macfadyen, 1941

Tristix suprajurassicum (Paalzow)

Plate 5, figure 12

Rhabdogonium suprajurassicum Paalzow, 1932, p. 125, pl. 9, fig. 7.
Triplasia somaliensis Macfadyen, 1935, p. 11, pl. 1, fig. 7a-b.
Trifarina bradyi, Bartenstein and Brand (*non* Cushman), 1937, p. 185, pl. 15b, fig. 1a-b.
Trifarina oolithica, Bartenstein and Brand (*non* Terquem), 1937, p. 186, pl. 11b, fig. 26; pl. 15b, fig. 2a-c.
Tristix triangularis Barnard, 1953, p. 190, text-fig. A5.

The aperture is finely but distinctly radiate. The proloculus is large and spherical and no microspheres have been recognized. In most specimens there are distinct crenulated keels on the three borders which extend into the prolocular area. In one test the borders are rounded and there are no keels, suggesting synonymy with *Tristix liasina* (Terquem and Berthelin). However, specimens are rare and relationships between the two species cannot be demonstrated from the present material.

Genus PSEUDONODOSARIA Boomgart, 1949

PSEUDONODOSARIA VULGATA (Borneman)

Plate 5, figure 3

Glandulina vulgata Borneman, 1854, p. 31, pl. 2, figs. 1a-b, 2.
Glandulina tenuis Borneman, 1854, p. 31, pl. 2, fig. 2a-b.
Pseudoglandulina vulgata, Bartenstein and Brand, 1937, p. 150, pl. 4, fig. 41; pl. 6, fig. 16; pl. 8, fig. 19; pl. 15a, fig. 15.

Specimens are rare, but appear to fall well within the range of variation of this highly variable species. The chambers are more bulbous and constricted at the sutures than is shown on Borneman's figures. The specimens most closely resemble the figures of Bartenstein and Brand.

PSEUDONODOSARIA HYBRIDA (Terquem and Berthelin)

Plate 5, figures 7-11

Glandulina hybrida Terquem and Berthelin, 1875, p. 22, pl. 1, fig. 26.
Pseudoglandulina irregularis, Bartenstein and Brand (*non* Franke), 1937, (pars), p. 151, pl. 8, fig. 21 only.

Test long, slender, straight or slightly arcuate, apiculate, rounded or suboval in cross-section; chambers numerous, varying in number from four to ten, generally greater in height than breadth, but highly irregular in early portion with some chambers very low, greatest increase in height after second chamber; sutures depressed or flush, varying considerably in single specimens; proloculus rounded, tiny; aperture terminal, large, rounded or slightly radiate.

The variational pattern of this species is similar to that of *Pseudonodosaria vulgata* (Borneman) as described by Barnard (1950b, p. 24) from the Lias of Byfield, and most of the chambers are highly irregular in size and shape. The two species are similar, but *P. hybrida,* which is the more common one in the English Bathonian, is distinguished by the more slender test and the blunter, less bullet-like shape of the last chamber. The shape of the last chamber is remarkably constant, even though the earlier ones are highly variable.

This species is common in the Cotswold area of the English Bathonian.

Material deposited at M.C.Z. No. 3362D.

Pseudonodosaria oviformis (Terquem)

Plate 5, figures 1-2

Glandulina oviformis Terquem, 1864a, p. 168, pl. 7, fig. 4a-b.
Nodosaria humilis, Jones and Parker (*non* Roemer), 1860, pl. 19, fig. 6.
Nodosaria glans, Jones and Parker (*non* d'Orbigny), 1860, pl. 19, fig. 7.
Pseudoglandulina oviformis, Bartenstein and Brand, 1937, p. 149, pl. 4, fig. 40.
Pseudoglandulina oviformis, Macfadyen, 1941, p. 47, pl. 3, fig. 47.
Pseudoglandulina oviformis, Barnard, 1950b, p. 24, pl. 1, fig. 6.

The specimens agree well with Terquem's figures, except that the outline of the test is perfectly smooth, and there is no constriction of the chambers at the sutures. In addition, the apertures are distinctly radiate, which is not indicated in the figure. The minute size, smooth surface and slightly fusiform shape distinguish the species. This species is characteristic of the Lower Jurassic, and has been recorded from numerous localities. In the English Bathonian it was observed only in the Lower Fuller's Earth Clay on the Dorset Coast, where the material consists of three specimens.

Pseudonodosaria pupoides (Borneman)

Plate 5, figures 4-6

Orthocerina pupoides Borneman, 1854, p. 35, pl. 3, fig. 16a-b.
Pseudoglandulina pupoides, Bartenstein and Brand, 1937, p. 150, pl. 5, fig. 30; pl. 8, fig. 20.

This species resembles *P. oviformis*, but is a larger, heavier form and is not as fusiform. Occasional specimens, however, are small and have thin, transparent walls.

This species occurs throughout most of the English Bathonian, but is common only in the Upper Fuller's Earth. Most of the specimens are poorly preserved, and more adequate material may reveal the present specimens to be variants of some other species of *Pseudonodosaria*.

Genus VAGINULINA d'Orbigny, 1826

Vaginulina clathrata (Terquem)

Plate 5, figures 20-22

Marginulina longuemari var. *clathrata* Terquem, 1864a, p. 192, pl. 8, figs. 16, 19a-b.

Frondicularia fenestrata Terquem, 1886, p. 43, pl. 4, fig. 35.
Vaginulina proxima, Franke (*non* Terquem), 1936, p. 85, pl. 8, fig. 34.
Vaginulina proxima, Bartenstein and Brand, 1937, p. 164 (pars), pl. 6, fig. 23 only.
Vaginulina clathrata, Barnard, 1950b, p. 29, pl. 1, figs. 8-10.

Material of this species from the Lias of Byfield has recently been described in great detail by Barnard (1950b). It is highly variable, particularly in the ornamentation and curvature of the test. Barnard illustrated three forms, in one of which the test is absolutely straight and in the other two the early portions are strongly curved. He interpreted the differences as being indicative of dimorphism, and designated the straight type as the megalosphere and the other two as the microspheres. However, there are no appreciable size differences among the proloculi of the three forms. If anything, the proloculi of the two curved types are slightly larger than that of the straight one. Furthermore, examination of Barnard's material reveals that all three types are linked by transitional forms. Consequently, there is no clear indication of dimorphism, although the forms figured by Barnard nicely illustrate the more important variational aspects of the species.

The specimens from the Bathonian are identical with the forms described by Barnard and show the same variational patterns, although they are considerably less abundant than in the Lias. They are also identical with one of the forms of *V. proxima* (Terquem) described by Bartenstein and Brand, but the variability of those specimens is not known.

Payard (1947) dealt with this and similar species described by Terquem, and having access to the Terquem collection erected five new species and two varieties. All of them appear to be individual variants of a single species.

This species (*sensu stricto*) occurs in the basal beds of the Lower Fuller's Earth Clay, and has not been observed in younger strata.

Vaginulina clathrata expensa n. subsp.

Plate 5, figures 23-26

Vaginulina proxima, Bartenstein and Brand (*non* Terquem), 1937, p. 164 (pars), pl. 8, fig. 27a-b; pl. 11b, fig. 13; pl. 14b, fig. 6a-b.

Test large, stout, broad in relation to height, straight or slightly curved; chambers numerous, about five to seven composing the test, increasing rapidly in breadth as added, only slightly so in height; sutures straight or slightly curved, depressed; surface covered by numerous strong costae, extending over greater portion of test; proloculus in megalosphere large, globular; aperture at peripheral margin, radiate.

Only one microsphere was observed, and it differed from the megalospheres only in the smaller size of the proloculus; there is no difference in the curvature of the early portion of the test. There is much modification in the development of the ribs, and although they are always strong, they are not always persistent. Some specimens are very broad, and on these the ribs tend to be less well developed away from the central portion of the test.

This subspecies differs from the forms of *V. clathrata* from the Lias, described by Barnard (see above), in being broader and in having a more irregular development of the ribs. There is much overlap between the two forms and they differ only in their patterns of variation: the subspecies lacks the slim, elongate types.

This subspecies is common in the Fuller's Earth Rock and the *Wattonensis* Beds, and was not observed in older rocks; consequently it stratigraphically succeeds *V. clathrata* (*sensu stricto*). The illustrations of Bartenstein and Brand suggest that *V. proxima* consists of two comparable forms which also occur in chronologic succession; the long straight form referable to *V. clathrata* (*sensu stricto*) occurs in the Lias Zeta while the broader forms referable to *V. clathrata cyprensa* are first shown to occur in the Dogger Alpha.

Material deposited at M.C.Z. No. 3366D.

Vaginulina contracta (Terquem)

Plate 5, figure 17

Marginulina contracta Terquem, 1868, p. 125, pl. 8, figs. 13-24.
Marginulina contracta, Terquem, 1886, p. 25, pl. 2, figs. 44-54.
Vaginulina contracta, Bartenstein and Brand, 1937, p. 162, pl. 12b, fig. 8; pl. 15a, fig. 23a-b; pl. 15c, fig. 11a-b.

This species is similar to *Vaginulina legumen* (Linné), but is flatter, smaller, and generally has fewer chambers. Occasional specimens have last chambers overlapping on the oral margin and are chevron shaped.

This species is common throughout the Bathonian.

Vaginulina harpa Roemer

Plate 5, figures 18-19

Vaginulina harpa Roemer, 1841, p. 96, (pars), pl. 15, fig. 12 only.
Vaginulina harpa, Haeusler, 1890, p. 108, pl. 15, figs. 22, 23, 27.
Vaginulina harpa, Macfadyen, 1935, p. 12, pl. 1, fig. 8a-b.
Vaginulina harpa, Bartenstein and Brand, 1937, p. 163, pl. 14b, fig. 7; pl. 14c, fig. 10; pl. 15a, fig. 24a-b; pl. 15c, fig. 12a-d.

The present specimens agree well with the figures cited, and are identical with the specimens illustrated by Bartenstein and Brand.

The species is rare, occurring only in the Lower Fuller's Earth Clay and the *Wattonensis* Beds on the Dorset Coast.

Vaginulina cf. V. hechti Bartenstein

Plate 5, figure 14

A single, broken specimen recovered from the *Wattonensis* Beds on the Dorset Coast consists of the first three chambers of the test. There are three oblique ribs on the proloculus. The proloculus is larger than that described by Bartenstein and Brand (1937, p. 165, pl. 8, fig. 21a-b), but otherwise compares favorably.

Vaginulina legumen (Linné)

Plate 5, figures 15-16

Vaginulina legumen Blake, 1876, p. 464, pl. 19, fig. 11.
Vaginulina legumen Haeusler, 1890, p. 107, pl. 14, fig. 49.
Vaginulina legumen Paalzow, 1917, p. 237, pl. 45, figs. 10-11.
Vaginulina legumen Bartenstein and Brand, 1937, p. 162, pl. 15a, fig. 22.

The present specimens exhibit much variation, particularly in the breadth of the test and in the shape of the proloculus. In some variants the test is slim, and there is no curvature in the

early portion, so that they are structurally identical with *Dentalina*. These variants are morphologically indistinguishable from *Dentalina mucronata* (Neugeboren), and can be separated from it only by their association with transient and more typical forms. The similarity of the "end forms" of the two species is illustrated in Figure 4A-J.

There are many records of this species from the Jurassic, although the type is a Recent form from the Mediterranean. The figure of the type in the Ellis and Messina *Catalogue of Foraminifera* reveals a large, heavy form which is distinctly keeled and has limbate sutures. Some variant forms in the Jurassic are comparable, but most of them are smaller with depressed sutures and lack keels. The relationships are uncertain and the Jurassic forms should probably be referred to a separate species.

Material deposited at M.C.Z. No. 3370B.

Vaginulina macilenta (Terquem)

Plate 5, figure 13

Marginulina macilenta Terquem, 1869, p. 12, pl. 7, figs. 1-18.
Vaginulina macilenta, Bartenstein and Brand, 1937, p. 163, pl. 11b, fig. 12a-b.

The present specimens are identical with those in the Bartenstein and Brand collection at the Senckenberg museum, Frankfurt a.M. These authors record this species from the Dogger Alpha through Delta in northwest Germany. In the present material it was observed only in the Lower Fuller's Earth Clay, where it is very rare.

Vaginulina sp. A.

Test small, curved, oval in cross-section, only slightly compressed, rounded on periphery; chambers varying in number from four to six, increasing in breadth as added, only slightly in height, last one very large compared to previous; sutures straight, thin, flush; proloculus round; aperture radiate.

These specimens, which occur sporadically throughout the Bathonian, are probably variants or immature forms of some species such as *Vaginulina legumen* or *V. contracta*, with which they often occur.

Material deposited at M.C.Z. No. 3372.

Genus CITHARINA d'Orbigny, 1839

Citharina colliezi (Terquem)

Plate 6, figures 1-2

Marginulina colliezi Terquem, 1866a, p. 430, pl. 17, figs. 10a-c.
Marginulina flabelloides Terquem, 1868, p. 102, pl. 6, figs. 1-30.
Vaginulina strigillata, Jones and Parker (*non* Reuss), 1860, p. 457, pl. 20, figs. 30-35.
Vaginulina cf. *V. flabelloides,* Deeke, 1884, p. 29, pl. 1, fig. 16.
Vaginulina flabelloides, Franke, 1936, p. 87, pl. 8, figs. 43, 44a-b.
Vaginulina flabelloides, Bartenstein and Brand, 1937, p. 164, pl. 6, fig. 27; pl. 8, fig. 30a-c; pl. 19, fig. 27; pl. 12b, fig. 9; pl. 14b, fig. 8 only.
Citharina colliezi, Barnard, 1950b, p. 14, pl. 3, fig. 1.

This species is represented by few individuals and is a distinctive form in the English Bathonian. However, in other regions where it occurs in abundance it is highly variable and is not easily distinguished from other species, notably *Citharina harpula* and *C. heteropleura.* This is particularly true at Fontoy (Moselle), where Terquem originally described these and other comparable species. The specimens in the Terquem collection include many that are transitional between very unlike types. Highly variable are the strength and number of ribs, and the outline of the test. The ribs range from fine striations typical of the species to heavy costae characteristic of the *Vaginulina proxima* and *V. inconstans* group. The shape of the tests varies from fanlike, as in *Citharina heteropleura,* to slim, narrow types as is found in *Vaginulina clathrata.* It is not known which if any of these specimens are the types, nor are the exact horizons at which the specimens occur known, so that the relationships of this complex group can not be ascertained until the type locality has been carefully recollected and topotypes have been examined.

The present specimens have been compared with those described by Barnard from the Lias, and are identical. The species is not common in the Bathonian, and perhaps for this reason exhibits little variation. It occurs in the Lower Fuller's Earth Clay and *Wattonensis* Beds of the Dorset Coast and the Bath areas, but was not observed at younger horizons.

Citharina heteropleura (Terquem)

Plate 6, figures 4-5

Marginulina heteropleura Terquem, 1868, p. 116, pl. 7, figs. 19-25.
Marginulina pinguis Terquem, 1868, p. 119, pl. 7, figs. 28-29.

Marginulina distensa Terquem, 1868, p. 120, pl. 7, fig. 30.
Marginulina flabelloides, Bartenstein and Brand (*non* Terquem), 1937, p. 164 (pars), pl. 14c, fig. 11; pl. 15a, fig. 25a-b.

This species is similar to *Citharina colliezi* but differs from it in the broader, more fan-shaped test. The sutures are depressed, resulting in chambers that are slightly bulbous. The ribbing is very fine, but is persistent and crosses the sutures. There is no morphologic overlap of the two species in the present material but the morphologic affinities appear to be close and perhaps they represent two stratigraphic subspecies. *C. heteropleura* was recovered only from the Upper Fuller's Earth Clay, while *C. colliezi* was not observed above the Fuller's Earth Rock. In northwest Germany Bartenstein and Brand have included both of these species in *Vaginulina flabelloides*. From examination of their figures, which are arranged stratigraphically, forms comparable to *Citharina colliezi* occur in the Lias, and the others comparable to *C. heteropleura* occur in the Dogger.

Citharina sp.

Plate 6, figure 3

Test large, thick, highly compressed, subtriangular in side view; chambers numbering eight, increasing rapidly in breadth as added, only slightly in height; sutures flush, mostly obscured by thirteen fine costae covering the surface, extending from proloculus to end of last chamber; proloculus small, subelliptical; aperture radiate, on a short neck formed by junction of margins.

The material consists of a single specimen recovered from the *Wattonensis* Beds on the Dorset Coast. The costae and plan of growth are similar to *Vaginulina harpa*, but the angular outline and thickness are distinctive.

Genus LINGULINA d'Orbigny, 1826

Lingulina dentaliniformis Terquem

Plate 6, figures 11-12

Lingulina dentaliniformis Terquem, 1870b, p. 339, pl. 25, figs. 1-3.
Lingulina dentaliniformis, Terquem, 1886, p. 12, figs. 27-29.
Lingulina dentaliniformis, Bartenstein and Brand, 1937, p. 152, pl. 10, fig. 20.

The test is smooth, but occasional specimens reveal faint striations when viewed under high power. This species is very similar to *Frondicularia dentaliniformis* and can be distinguished from it only by the sutures, which are transverse or slightly arched. The convexity of the sutures is variable, however, and some specimens are difficult to identify.

This species is rare in the English Bathonian.

Lingulina dolium (Terquem)

Plate 6, figures 9-10

Frondicularia dolium Terquem, 1870b, p. 338, pl. 23, figs. 9-12.
non Lingulina dolium Terquem, 1870b, p. 340, pl. 25, figs. 4-5.

Test smooth, compressed, initial end conical, remainder rectangular; chambers varying in number from four to ten, increasing rapidly in height after second or third chamber, then increasing gradually as added, with no increase in breadth; sutures slightly depressed, generally tranverse, but often with sinuous pattern; proloculus minute, globular; aperture elongate, slit-like.

Terquem's figure shows a projected initial end, with the proloculus and succeeding chamber combined, so that the minute proloculus is not apparent. This is probably an inaccuraey in the drawing, as the specimen in the Terquem collection clearly has a tiny proloculus, identical with those in the present specimens. The sutures of the specimens in the collection are decidedly more sinuous than shown in Terquem's figure.

A similar form is *Lingulina ovalis* Schwager (*non* Terquem and Berthelin) described from the Lower Oxfordian of Germany. This species exhibits the same sinuous sutural pattern, but the proloculus is much larger, and the chambers are more constricted at the sutures.

Lingulina laevissima (Terquem)

Plate 6, figures 6-8

Frondicularia laevissima Terquem, 1866b, p. 481, pl. 19, fig. 19.
Lingulina laevissima, Franke, 1936, p. 62, pl. 6, fig. 11.
Lingulina taenoides Franke, 1936, p. 62, pl. 6, fig. 12.

The original description of this species by Terquem is as follows (translated from the French): "Test elongate, compressed, straight, smooth, obtuse at both ends, periphery rounded, composed of eight transverse chambers, the first ones plane, quadrangular, the last two a little extended, arched in the middle, aperture oval."

In these specimens the last chambers are not inflated, and there is only the slightest trace of arched sutures. In all cases the apertures are indistinct, and it can not be determined if they are radiate or rounded. They agreee best with *Lingulina taenoides* Franke, which I believe is a synonym of *L. laevissima*.

There is much divergence of opinion concerning this species, and a variety of forms have been included under this name. Macfadyen (1941, p. 50, pl. 3, fig. 51a-b), for example, has ignored Franke's *L. laevissima*, and has, instead, included Franke's *L. lanceolata* as a synonym. This is a very slim form with highly arched sutures. Barnard (1956, p. 272) regards Franke's *L. laevissima* and *L. lanceolata* as one species. In my opinion none of these forms agree as well with the figure of the type as do those figured by Franke.

This species occurs commonly in the Bathonian, but individuals are not common. Specimens are generally squashed and poorly preserved.

Lingulina sp. A

Plate 6, figure 15

Test elongate, slightly rounded in cross-section; chambers numbering eight, first five minute, then increasing rapidly in width, producing spiked appearance to lower portion of test, last chamber elongate, bullet shaped; sutures slightly depressed, indistinct, slightly arched; aperture rounded.

The arched sutures resemble *Frondicularia*, but are not truly "V"-shaped. The apiculate initial end, composed of four minute chambers, distinguishes this form from any other encountered, though possibly it may be a variant of one of the smooth *Lingulina* species or even of one of *Frondicularia*.

This form is rare and was observed only in the Cotswolds.

Lingulina sp. B

Plate 6, figure 14

Test highly perforate, compressed, elongate, oval in cross-section; chambers numbering three, last one about equal in length to other two combined; aperture central radiate.

The highly perforate test and very long third chamber are very distinctive, and the test is unlike that of any other form encountered.

The material consists of one specimen, which was recovered from the Wychwood Beds, in the Kirtlington Cement Works, Oxfordshire.

Lingulina sp. C

Plate 6, figure 16

Test compressed, smooth, triangular, slightly twisted; chambers numbering six or seven, increasing in size as added, broader than high, but growth somewhat irregular, constricted at the margins; sutures slightly convex, mostly concentric, but with sinuous pattern in last two chambers; proloculus tiny, rounded; aperture central, indistinct in all specimens, but apparently rounded.

This form bears some resemblance to *Lingulina dentaliniformis* but is much broader, and exhibits a sinuous sutural pattern in the later chambers. The wall is heavier, and the surface appears to be rugose, although this may be due to the state of preservation.

Specimens are rare, and were observed only in the Cotswolds.

Genus FRONDICULARIA Defrance, 1824

Frondicularia dentaliniformis Terquem

Plate 6, figures 17-19

Frondicularia dentaliniformis Terquem, 1870b, p. 319, pl. 23, figs. 1-8.
Frondicularis dentaliniformis, Bartenstein and Brand, 1937, p. 153, pl. 10, fig. 22.

All of the specimens are characterized by the constricted chambers, and the markedly depressed, convex sutures. The

aperture is variable, but the radiate form appears to be the exception. The distribution of the species is sporadic, and specimens per sample are few, so that the variation could not be observed in single populations, and the description here is based on isolated specimens from various localities and horizons.

This species resembles, and undoubtedly is closely related to, *Frondicularia nodosaria* and *Lingulina dentaliniformis*. It differs from the former in the lack of clear-cut costae, the greater constriction of the chambers and in the more deeply depressed sutures. It can be distinguished from the latter by the greater convexity of the sutures. It is possible that all three species are transitional, as is suggested by Bartenstein and Brand (1937, p. 109); however, the relationships are not apparent on the basis of the present rather sparsely distributed material.

Frondicularia involuta Terquem

Plate 7, figures 1-3

Frondicularia involuta Terquem, 1866a (pars), p. 403, pl. 15, fig. 3a-b only.
Frondicularia complanata, Jones and Parker (*non* Defrance), 1860, p. 457, pl. 1, fig. 19.
Frondicularia oolithica Terquem, 1870b, p. 315 (pars), pl. 22, figs. 1-6.
Frondicularia complanata, Blake, 1876, p. 468, pl. 19, fig. 20.
Frondicularia lignaria, Bartenstein and Brand (*non* Terquem), 1937, p. 152, pl. 8, fig. 25a-b; pl. 10, fig. 21; pl. 11a, fig. 7; pl. 11b, fig. 8; pl. 12a, fig. 5; pl. 12b, fig. 7; pl. 13, fig. 11; pl. 14, fig. 6.
Frondicularia involuta, Barnard, 1950b, p. 13, pl. 2, figs. 8-9.

In the Bathonian this species exhibits little variation, and the specimens are consistently broad. Barnard noted the same situation in the Lias. The present specimens agree well with those described from the Lias by Barnard, except that the Bathonian ones are more robust and the chambers are slightly higher.

Frondicularia intumescens Borneman

Plate 6, figure 13

Frondicularia intumescens Borneman, 1854, p. 36, pl. 3, fig. 19a-c.
Frondicularia nitida, Franke (*non* Terquem), 1936, p. 68, pl. 7, figs. 1-3.
Frondicularia sacculus, Franke (*non* Terquem), 1936, p. 68, pl. 7, fig. 4.
Frondicularia intumescens, Franke, 1936, p. 67, pl. 6, fig. 27.

Frondicularia nitida, Bartenstein and Brand, 1937, p. 153, pl. 4, fig. 45.
Frondicularia intumescens, Bartenstein and Brand, 1937, p. 155, pl. 2b, fig. 19; pl. 4, fig. 55; pl. 5, fig. 35.

Although these specimens differ somewhat from the figure of the type, they compare well with some of the figures cited, and appear to fall within the limits of this highly variable species. The material consists of 3 small specimens, from the Forest Marble, possibly representing immature individuals. Previous records of this species are all from the Lias.

Frondicularia lignaria Terquem

Plate 6, figures 20-21

Frondicularia lignaria Terquem, 1866b, p. 480, pl. 19, fig. 14.
Frondicularia varians Terquem, 1866b, p. 480, pl. 19, fig. 15a-b.
non Frondicularia lignaria, Bartenstein and Brand, 1937, p. 152, many figures.
Frondicularia lignaria, Barnard, 1950a, p. 371, text-fig. 3g.

This species is distinguished by the tiny proloculus, sharply angular sutures and smooth margin. Barnard's figure shows a more rounded outline, sutures which are less angular, and greater overlap of the last chamber which composes about two-thirds of the test. Despite these differences there is good agreement, and the Lias form is considered identical.

This species is rare, and was observed only in the Lower Fuller's Earth Clay.

Frondicularia nodosaria Terquem

Plate 7, figures 4-6

Frondicularia nodosaria Terquem, 1870b, p. 319, pl. 22, figs. 25-30.
Frondicularia nodosaria, Bartenstein and Brand, 1937, p. 155, pl. 12a, fig. 6; pl. 13, fig. 14; pl. 15a, fig. 21.
Lingulina nodosaria, Barnard, 1950b, p. 29, text-fig. 16.

The specimens are not as broad as those figured by Terquem, and the sutures are always distinctly arched. This species is similar to *Frondicularia oolithica* Terquem figured by Bartenstein and Brand (1937, p. 155, many figures), but the latter form consistently lacks costae or any visible striations.

Frondicularia nodosaria Terquem var. A n.var.

Plate 7, figures 7-8

This variety differs from other forms of this species encountered in the present material in that the sutures are decidedly less convex and are almost transverse. Specimens are rare, and consist mostly of fragments. The observed distribution is confined to the Lower Fuller's Earth Clay.

Frondicularia spissa Terquem

Plate 6, figures 22-24

Frondicularia spissa Terquem, 1870b, p. 317, pl. 22, fig. 10.
Frondicularia spatulata Terquem, 1870b, p. 317, pl. 22, figs. 11-17.
Frondicularia spatulata, Franke, 1936, p. 66, pl. 6, fig. 23.
Frondicularia spatulata, Bartenstein and Brand, 1937, p. 154, pl. 13, fig. 13a-b; pl. 14c, fig. 8; pl. 15a, fig. 19a-b; pl. 15c, fig. 9a-b.
Frondicularia lingulaeformis, Bartenstein and Brand (*non* Schwager), 1937, p. 154, pl. 14c, fig. 7.

This species is similar to *Frondicularia nodosaria,* but is generally broader than the latter species, and is not as constricted at the sutures.

Specimens are identical with those examined in the Terquem collection.

Genus SARACENARIA Defrance, 1824

Saracenaria triquetra (Gumbel)

Cristellaria triquetra Gumbel, 1862, p. 225, pl. 3, fig. 28a-c.
Cristellaria (*Saracenaria*) *triquetra* Bartenstein and Brand, 1937, p. 170, pl. 14b, fig. 12a-b; pl. 15a, fig. 21a-b; pl. 15c, fig. 16.
Saracenella triquetra Barnard, 1953, p. 190, text-fig. B4a-b.

The delicate keel is barely visible on some specimens, probably because of preservation. Specimens also show marked differences in the degree of coil, some being almost completely uncoiled as in *Saracenella.*

Material deposited at M.C.Z. No. 3389.

Genus LAGENA Walker and Boys

Lagena striata (d'Orbigny)

Oolina striata d'Orbigny, 1839, p. 21, pl. 5, fig. 12.
Lagena natrii Blake, 1876, p. 453, pl. 8, fig. 8.
Lagena striata, Haeusler, 1890, pl. 8, fig. 12.

These rare specimens are small and have distinctly radiate apertures.

Material deposited at M.C.Z. No. 3390.

Lagena globosa (Montagu)

Material deposited at M.C.Z. No. 3390.

Vermiculum globosum Montagu, 1803, in Ellis and Messina, *Catalogue of Foraminifera.*

Lagena globosa, Seibold and Seibold, 1953, p. 67, pl. 4, fig. 17.

This species differs from the preceding in being larger, more robust and lacking striations. It is rare in the English Bathonian.

Material deposited at M.C.Z. No. 3391.

Family POLYMORPHINIDAE

Genus EOGUTTULINA Cushman and Ozawa, 1930

Eoguttulina angustata (Terquem)

Plate 7, figure 12

Polymorphina angustata Terquem, 1864b, p. 296, pl. 12, figs. 33-35.

Eoguttulina polygona, Bartenstein and Brand (*non* Terquem), 1937, p. 179, pl. 13, fig. 19a-c.

The test is small, compressed, and composed of four to five chambers arranged biserially for the most part, with a small spiral in the early portion.

Cushman and Ozawa (1930, p. 8) state that the chambers in this species are added in planes ninety degrees apart from one another, and the chamber arrangement is tetraserial. This interpretation is based on Terquem's type figures, which, however, show side views only, with no clear indications of the chamber arrangement.

This species is similar to *Eoguttulina liassica,* but is more compressed, has more depressed sutures, and later chambers that are arranged biserially. There is much variation, however, and additional material may show these species to be transitional.

This species is comparatively rare, although it occurs at a number of localities in various parts of the Bathonian.

Eoguttulina liassica (Strickland)

Plate 7, figures 9-11

Polymorphina liassica Strickland, 1846, p. 31, text fig. b.
Eoguttulina liassica, Cushman and Ozawa, 1930, p. 7, pl. 1, fig. 2a-c.
Eoguttulina liassica, Bartenstein and Brand, 1937, p. 178, pl. 1a, fig. 24a-b; pl. 2a, fig. 23; pl. 2b, fig. 35; pl. 3, fig. 49; pl. 4, fig. 74a-b; pl. 5, fig. 69a-b.
Eoguttulina oolithica Bartenstein and Brand, 1937, p. 179, pl. 8, fig. 34a-b; pl. 10, fig. 43a-b; pl. 11a, fig. 18a-c; pl. 11b, fig. 24a-b; pl. 12b, fig. 18; pl. 15a, fig. 37a-b.

Most often the tests consist of three chambers, but occasional specimens have four or five chambers. Each of these is farther removed from the base than the previous one, and the arrangement is vaguely reminiscent of a spiral. The test contains an internal tube which is clearly visible in the well preserved specimens under transmitted light.

This species is common throughout the Bathonian, and is particularly abundant in Northamptonshire and Rutland.

Genus PALEOPOLYMORPHINA Cushman and Ozawa, 1930

Paleopolymorphina pleurostomelloides (Franke)

Plate 7, figure 13

Polymorphina pleurostomelloides Franke, 1928, p. 121, pl. 11, fig. 11.
Paleopolymorphina pleurostomelloides, Cushman and Ozawa, 1930, p. 112, pl. 28, fig. 5a-b.

This species was selected by Cushman and Ozawa as the genotype of *Paleopolymorphina* and their description of the species is as follows: "Test small, more or less cylindrical, tapering towards the initial end; chambers inflated, oval, but little embracing, alternating, arranged in an entirely biserial series, each farther removed from the base; sutures oblique, much depressed, distinct, wall smooth; aperture radiate." However, the description of the genus is as follows: "Test with early chambers spiral, later ones becoming biserial-Genotype-*Polymorphina pleurostomelloides* (Franke)." It can be seen that the description of the genotype does not correspond to that of the genus, as this species is biserial throughout.

This species is very rare in the Bathonian, but specimens included here compare well with figures of the type from the Cretaceous, except that the chambers of the Bathonian forms are somewhat more elongate, tending to become uniserial in the latest portion, and there are six, instead of seven chambers.

Genus GLOBULINA d'Orbigny, 1839

GLOBULINA sp.

Plate 7, figure 14

Rare, tiny, globular specimens are best referred to this genus. The sutures are indistinct, so that the growth plan is uncertain. Superficially, however, they closely resemble other forms of *Globulina*.

Family HETEROHELICIDAE

Genus PLECTOFRONDICULARIA Liebus, 1903

PLECTOFRONDICULARIA PARADOXA (Berthelin)

Plate 7, figure 16

Frondicularia paradoxa Berthelin, 1879, p. 33, pl. 1, figs. 12-17.
Frondicularia paradoxa, Issler, 1908, p. 58, pl. 3, figs. 119-121.
Flabellina paradoxa, Bartenstein and Brand, 1937, p. 168, pl. 4, fig. 63a-c.
Plectofrondicularia paradoxa, Macfadyen, 1941, p. 66, pl. 4, figs. 67-68.

The present material consists of two specimens, one of which is a microsphere and the other a megalosphere. The microsphere is the larger of the two, and has minute spines projecting at the margins. Both specimens agree well with those previously described from the Lias, except that in these the biserial portion constitutes a smaller part of the test than appears to be typical of this species.

Family BULIMINIDAE

Genus BOLIVINA d'Orbigny, 1839

BOLIVINA RHUMBLERI Franke

Plate 7, figure 15

Bolivina nitida, Haeusler (*non* Brady), 1890, p. 79, pl. 12, figs. 38-39.
Bolivina rhumbleri Franke, 1936, p. 126, pl. 12, fig. 21.

Bolivina rhumbleri rhumbleri, Bartenstein and Brand, 1937, p. 184, pl. 4, fig. 73a-c; pl. 5, fig. 72a-c.

Specimens are very rare. The aperture is slit-like, and the test is smooth with flush sutures. The specimens compare best with Haeusler's figures, and are slimmer and more fusiform than that illustrated by Franke.

Family ROTALIIDAE

Genus SPIRILLINA Ehrenberg, 1843

Spirillina infima (Strickland)

Orbis infimus Strickland, 1846, p. 30, text fig. A.

Spirillina polygyrata, Bartenstein and Brand (*non* Gumbel), 1937, p. 131, pl. 4, fig. 10; pl. 6, fig. 7; pl. 14c, fig. 3; pl. 15a, fig. 2a-c; pl. 15c, fig. 1a-d.

Spirillina punctilata, Bartenstein and Brand (*non* Terquem), 1937, p. 132, pl. 12b, fig. 2a-d; pl. 14c, fig. 4a-b.

Included here are small, planispiral tubular forms which have thin walls and a vitreous luster. When observed under high power pores are visible on some tests. Poorly preserved specimens in which the wall has been altered are inseparable from *Cornuspira* or *Ammodiscus.* The vitreous appearance of the wall does not offer a clue to the generic position, as Mr. McNichol of University College, London, has observed that altered specimens of *Cornuspira* sometimes have a vitreous luster, but can be seen to be imperforate under very high magnifications (personal communication, 1955). The problem of separation, therefore, is difficult.

A similar form is *Spirillina tenuissima* Gumbel. Topotypes of this species, however, are considerably larger and more robust.

The forms included here are extremely common throughout the Bathonian.

Genus PATELLINA Williamson, 1858

Patellina oolithica Terquem

Plate 7, figures 21-22

Patellina oolithica Terquem, 1883, p. 382, pl. 45, figs. 3-4.

Spirillina oolithica Terquem, 1886, p. 59, pl. 7, figs. 2-4.

The present specimens resemble *Trocholina nidiformis* (Bruckman), but the last whorl is divided into four chambers, and

there are no clearly defined pillars on the ventral surface. The Jurassic forms of this genus are clearly more simple than their recent counterparts, particularly the genotype, *Patellina corrugata* Williamson. However, the authority of Cushman (1930, p. 14) is followed in retaining the Jurassic forms in this genus.

Genus DISCORBIS Lamarck, 1804

Discorbis dreheri Bartenstein

Plate 7, figures 23-25

Discorbis dreheri Bartenstein *in* Bartenstein and Brand, 1937, p. 192, pl. 6, fig. 45a-b; pl. 8, fig. 42a-e; pl. 10, fig. 47a-d.

A number of specimens collected from various localities compare well with the figures cited, but the preservation is rather poor, and the structure is not entirely visible. Most individuals are plano-convex, although some are biconvex, and the ventral margin is slightly indented. Most of the specimens are covered with a layer of calcite which obscures many of the surface features and the aperture. On two specimens, however, a slit-like aperture can be seen which extends along the umbilical margin of the last chamber. The sutures are flush or slightly depressed, and the chambers are slightly bulbous.

Hofker (1953) has referred this species to *Rheinholdella* on the basis of tooth plate structure. Several sections were made from the present material, but no internal structure was revealed, possibly due to poor preservation.

Genus EPISTOMINA Terquem, 1883

Epistomina stelligera (Reuss)

Plate 7, figures 17-20

Rotalina stelligera Reuss, 1854, p. 69, pl. 25, fig. 15a-c.
Epistomina stelligera, Bruckman, 1904, p. 23, pl. 4, figs. 10-11.
Epistomina caracolla, Paalzow (*non* Roemer), 1932, p. 142, pl. 11, figs. 12-14.
Epistomina stelligera, Bartenstein and Brand, 1937, p. 191, pl. 11a, fig. 21a-e; pl. 11c, fig. 3a-f; pl. 12a, fig. 27a-b; pl. 12b, fig. 20a-b; pl. 13, fig. 27a-d; pl. 14b, fig. 21a-c; pl. 14c, fig. 18a-b.

Many of the specimens are coated with secondary calcite, and much of the structure is not visible. However, on those

tests which are free of this, the peripheral aperture can be seen to be situated close to the ventral margin. No aperture was observed at the base of the apertural face. The keel is very small, delicate, and is distinctly serrate; however in most specimens the keel is not present, probably because of erosion. A poorly developed reticulate pattern appears on the umbonal region of some specimens.

This species resembles *Epistomina mosquensis*, but is considerably smaller and lacks the heavy sculpturing on the umbonal region.

Family ANOMALINIDAE

Genus ANOMALINA, d'Orbigny, 1826

Anomalina liassica Issler

Plate 7, figure 26

Anomalina liassica Issler, 1908, p. 93, pl. 7, figs. 331-332.
Anomalina liassica, Franke, 1936, p. 128, pl. 12, figs. 27a-b.
Anomalina liassica, Bartenstein and Brand, 1937, p. 191, pl. 6, fig. 44; pl. 8, fig. 41.

The material consists of one specimen which is very small and has six chambers in the last whorl. The test is evolute, and only slightly trochoid. The aperture is small and slit-like and is situated at the base of the last chamber, extending slightly on the dorsal side. The specimen is smaller than those figured by Issler and is less stout, but is otherwise identical.

The specimen was recovered from the Upper Fuller's Earth Clay at the Combe Hay Fuller's Earth Works, Bath.

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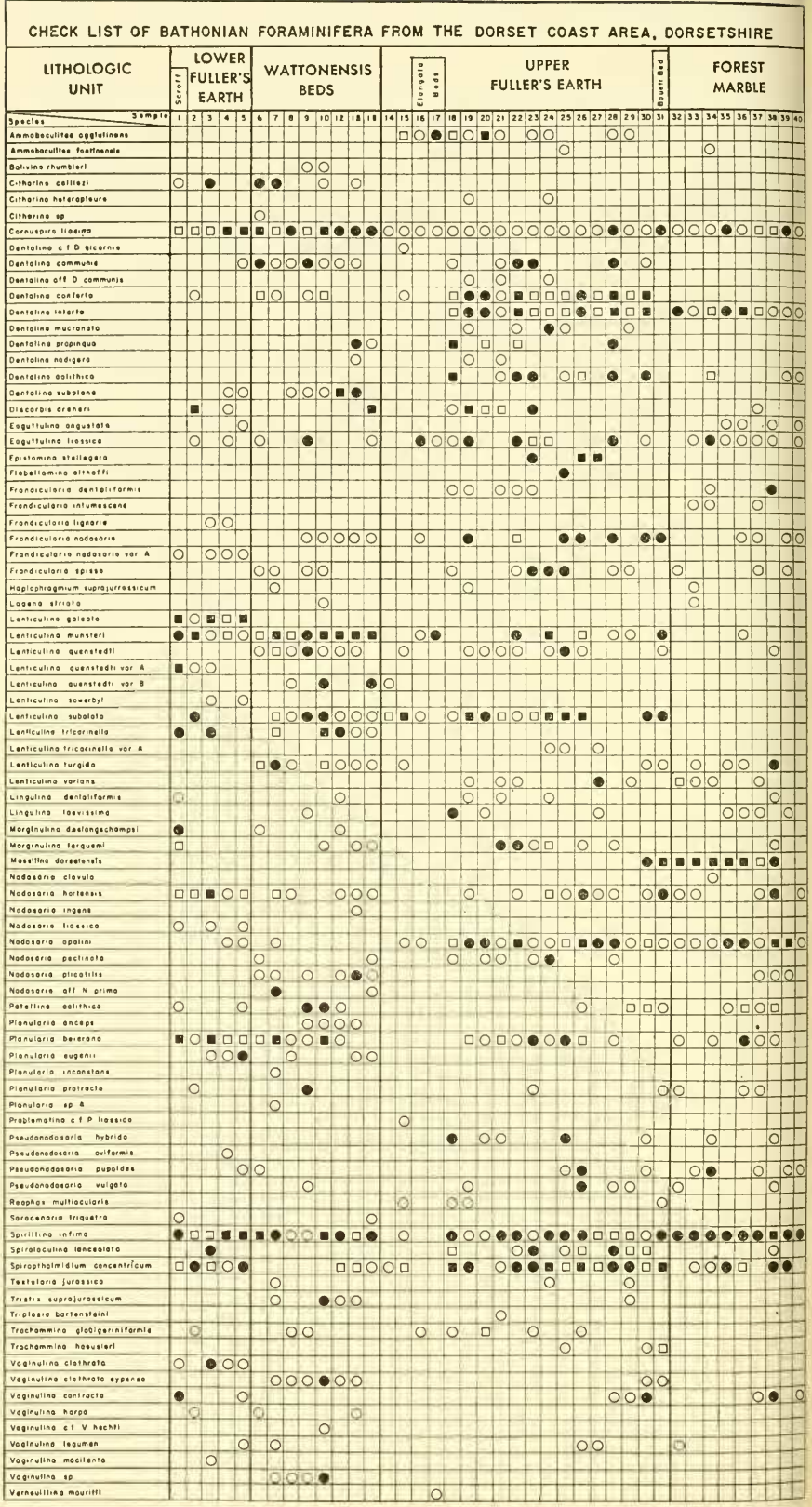
CHECK LIST OF BATHONIAN FORAMINIFERA FROM THE DORSET COAST AREA, DORSETSHIRE



SUPPLEMENTARY LOCALITY DATA

Dorset Coast

Sample No. shown in Table 1	Field sample No.
1	DoBu4
2	DoBu3
3	DoBu5
4	DoBu1
5	DoBu2
6	DoEm0
7	DoEm1
8	DoEm2
9	DoEm3
10	DoEm4
11	DoEm5
12	DoEm6
13	DoEm7
14	DoH2
15	DoH1
16	DoH3
17	DoH4
18	DoW1
19	DoC10
20	DoC9
21	DoC8
22	DoC7
23	DoC6
24	DoC5
25	DoC4
26	DoC2
27	DoC1
28	DoH7
29	DoH6
30	DoH5
31	DoH8
32	DoWA
33	DoWC
34	DoWB
35	DoWD
36	DoWE
37	DoWG
38	DoWF
39	DoWH
40	DoWI

Table 2. Foraminifera from the Lower Fuller's Earth Clay at Midford (Richardson, 1910, p. 427).

Sample BMF1

Bolivina rhumbleri	Rare
Cornuspira liasina	Common
Eoguttulina liassica	Rare
Frondicularia nodosaria var. A	Few
Haplophragmium suprajurassicum	Rare
Lenticulina munsteri	Few
Lenticulina quenstedti	Abundant
Lenticulina quenstedti var. A	Rare
Lenticulina tricarinella	Rare
Lenticulina turgida	Rare
Nodosaria hortensis	Few
Nodosaria opalini	Rare
Planularia beierana	Common
Pseudonodosaria pupoides	Rare
Pseudonodosaria vulgata	Rare
Spirillina infima	Few
Spirophthalmidium concentricum	Common
Vaginulina clathrata	Rare

Sample BMF2

Dentalina oolithica	Rare
Eoguttulina liassica	Rare
Frondicularia nodosaria	Rare
Lenticulina galeata	Few
Lenticulina quenstedti	Common
Lenticulina quenstedti var. A	Few
Lenticulina tricarinella	Common
Lenticulina turgida	Rare
Nodosaria hortensis	Rare
Nodosaria opalini	Rare
Patellina oolithica	Few
Planularia protracta	Few
Pseudonodosaria vulgata	Rare
Reophax multilocularis	Rare
Saracenaria triquetra	Rare
Spirillina infima	Abundant
Trochammina haeusleri	Rare
Vaginulina clathrata	Few

Table 3. Foraminifera from the Lower Fuller's Earth Clay, at the road cut between Maperton and Charleton-Horetorne (Richardson, 1909, p. 213).

Sample BaM1	
Cornuspira liasina	Abundant
Dentalina communis	Rare
Dentalina mucronata	Rare
Dentalina oolithica	Rare
Dentalina propinqua	Rare
Dentalina subplana	Few
Eoguttulina liassica	Few
Frondicularia dentaliniformis?	Rare
Frondicularia nodosaria	Rare
Frondicularia spissa	Rare
Lenticulina munsteri	Common
Lingulina laevissima	Rare
Marginulina terquemi	Rare
Nodosaria opalini	Rare
Nodosaria aff. N. prima	Common
Patellina oolithica	Few
Planularia beierana	Abundant
Saracenaria triquetra	Few
Spirophthalmidium concentricum	Common

Table 4. Foraminifera from the Lower Fuller's Earth Clay?, at Box.

Sample BC012 (about 12 feet below the contact of the Fuller's Earth Rock?)

Citharina colliezi	Rare
Dentalina communis	Few
Dentalina subplana	Rare
Eoguttulina liassica	Few
Lenticulina munsteri	Common
Lenticulina subalata	Rare
Nodosaria opalini	Rare
Planularia beierana	Abundant
Spirillina infima	Rare
Vaginulina elathrata expensa	Few
Vaginulina sp. A	Rare

Sample BC014 (about 5 feet below contact of Fuller's Earth Rock?)

Dentalina intorta	Few
Lenticulina munsteri	Rare
Lenticulina subalata	Rare
Lenticulina tricarinella	Rare
Lingulina laevissima	Rare
Patellina oolithica	Rare
Planularia beierana	Abundant
Pseudonodosaria pupoides	Rare

Table 5. Foraminifera from the Fuller's Earth Rock, between Maperton and Charleton-Horetorne (Richardson, 1909, p. 213).

1—(Sample BaM2) In marls of bed f, about 1½ ft. below bed e.

2—(Sample BaM3) In clay parting of bed e, about 2 ft. above bed f.

3—(Sample BaM4) In "Ornithella marl."

A, abundant; C, common; F, few; R, rare.

	1	2	3
Citharina colliezi		R	
Dentalina conferta		R	
Dentalina intorta	R	R	
Dentalina oolithica		R	
Dentalina propinqua	R	R	
Dentalina subplana	R	R	R
Eoguttulina liassica	R	R	
Frondicularia dentaliniformis	R	R	
Frondicularia nodosaria	R	R	R
Lenticulina munsteri	F	F	A
Lenticulina quenstedti		R	R
Lenticulina quenstedti var. B	R	R	F
Lenticulina subalata	C	F	
Lenticulina tricarinella	R		A
Lenticulina turgida	R		
Lingulina laevissima	R	R	
Marginulina terquemi	R		
Nodosaria hortensis	R	R	F
Nodosaria aff. N. issleri	R		R
Nodosaria opalini	R	R	
Nodosaria aff. N. prima		R	R
Patellina oolithica	F	F	
Planularia beierana	R	C	F
Planularia protracta	R	F	R
Pseudonodosaria pupoides		R	
Pseudonodosaria vulgata	R		
Spirillina infima	A	A	C
Trochammina haeusleri	R		
Vaginulina clathrata expensa		R	A
Vaginulina contracta	C		R
Vaginulina sp.	R	R	R

Table 6. Foraminifera from the interval between the *Acuminata* Bed and the "Fuller's Earth Rock proper," Cross Ways Inn (Cox, 1941, p. 20).

	Sample BCR1
Dentalina intorta	Rare
Dentalina propinqua	Rare
Flabellamina althoffi	Rare
Frondicularia nodosaria	Rare
Haplophragmium suprajurassicum	Common
Lenticulina munsteri	Common
Lenticulina quenstedti	Few
Lenticulina tricarinella	Abundant
Nodosaria subplana	Rare
Planularia beierana	Abundant
Pseudonodosaria pupoides	Rare
Spirillina infima	Few
Spirophthalmidium concentricum	Rare
Triplasia bartensteini	Common
Vaginulina clathrata cypensa	Common
Vaginulina sp. A	Rare

Table 7. Foraminifera from the Upper Fuller's Earth Clay, Combe Hay Fuller's Earth Works, Bath.

(Samples BCH1, BCH3, BCH4)

	1	2	3
Ammobaculites agglutinans			R
Ammobaculites fontinensis		R	
Anomalina liassica			R
Citharina heteropleura			R
Citharina sp. A		R	
Cornuspira liasina	C	A	C
Dentalina communis	R	R	F
Dentalina aff. D. communis	R		
Dentalina intorta	R	F	R
Dentalina propinqua		R	
Eoguttulina angustata	R	R	F
Eoguttulina liassica	F	C	F
Frondicularia involuta	R		
Frondicularia nodosaria	R		R
Lenticulina munsteri		F	R
Lenticulina subalata		R	
Lingulina dentaliniformis	R	R	R
Lingulina laevissima		R	
Marginulina terquemi			R
Nodosaria hortensis	R	R	
Nodosaria aff. N. issleri		R	
Nodosaria opalini	F	R	
Patellina oolithica			R
Planularia beierana	F	F	F
Pseudonodosaria hybrida	R		R
Spirillina infima	C	C	C
Spirophthalmidium concentricum	R	R	R
Trochammina haeusleri	F		R
Vaginulina contracta	A	A	C

Table 8. Foraminifera from the Upper Fuller's Earth Clay, Vernham Wood.

1—(BFW5) From middle of bed e

2—(BFW4) From clay band in bed d

3—(BFW2) From bottom of bed b

4—(BFW1) From top of bed b

	1	2	3	4
Dentalina communis		R		
Dentalina intorta	C	C		
Dentalina propinqua		R		
Eoguttulina angustata	R			
Eoguttulina liassica	C	C	F	
Haplophragmum suprajurassicum	R	F	R	R
Frondicularia involuta		R		R
Frondicularia spissa		R		
Lenticulina munsteri		C		R
Lenticulina subalata		F		
Lenticulina turgida?	R			
Lenticulina varians	C	R	A	F
Lingulina dolium			R	
Nodosaria hortensis		R	R	R
Nodosaria opalini		R	R	R
Patellina oolithica		F		
Planularia anceps			R	R
Planularia protracta	F	F		R
Pseudonodosaria pupoides		R		
Spirillina infima	A	A	A	A
Tristix suprajurassicum			R	
Triplasia bartensteini		F		F
Trochammina globigeriniformis	R			
Trochammina haeusleri		R	C	R
Vaginulina harpa	R			
Vaginulina legumen	F	A	A	F

Table 9. Foraminifera from the Upper Fuller's Earth Clay, Henley Hill, Box.

1—(Sample BC016) about 10 feet below contact of Great Oolite Limestones.
2—(Sample BC015) 2 feet below contact.

	1	2
Cornuspira liasina	C	A
Dentalina aff. D. communis	R	R
Dentalina intorta	C	F
Dentalina oolithica		R
Dentalina propinqua		R
Eoguttulina liassica	F	F
Frondicularia dentaliniformis		R
Frondicularia involuta	R	
Frondicularia nodosaria		C
Lenticulina munsteri	R	A
Lenticulina subalata	C	
Lenticulina tricarinella		R
Lenticulina turgida	R	F
Lingulina dolium	F	
Lingulina laevissima		F
Nodosaria hortensis		R
Nodosaria opalini	R	R
Planularia beierana	F	A
Planularia protracta		R
Pseudonodosaria hybrida		R
Pseudonodosaria pupoides	R	R
Saracenaria triquetra		R
Spirillina infima	F	F
Spirophthalmidium concentricum	R	F
Trochammina globigeriniformis		R
Trochammina haeusleri		C
Vaginulina harpa		R
Vaginulina sp. A	R	F

Table 10. Foraminifera from the Bradford Clay, Bradford-on-Avon.

1—(Sample BBC5) 1 ft. above fossil bed.
2—(Sample BBC4) 3 ft. above fossil bed.
3—(Sample BBC3) 5 ft. above fossil bed.
4—(Sample BBC1) 7 ft. above fossil bed.

	1	2	3	4
Ammobaculites agglutinans	A	A	R	R
Dentalina communis	R	R		
Dentalina aff. D. communis		R		R
Dentalina intorta	F	F	F	F
Dentalina oolithica	F	F	F	F
Dentalina propinqua	F	R	F	F
Dentalina subplana		R	R	R
Eoguttulina angustata		R		R
Eoguttulina liassica			R	F
Frondicularia dentaliniformis		R		
Frondicularia nodosaria	R			R
Frondicularia spissa				R
Lingulina dolium	R			
Lingulina laevissima		R	R	
Marginulina terquemi	R	R		
Massilina dorsetensis			R	C
Nodosaria hortensis		R		
Nodosaria opalini	R	R		F
Patellina oolithica		R		
Planularia beierana				R
Pseudonodosaria hybrida			R	
Pseudonodosaria vulgata				R
Spirillina infima	C	F	F	C
Spiroloculina lanceolata				C
Spirophthalmidium concentricum	R			F
Trochammina globigeriniformis	R			
Vaginulina contracta	R			R

Table 11. Foraminifera from the Forest Marble, Monk Quarry, Corsham.

1—(Sample BCO1) 38 ft. above Upper Rag Bed.
2—(Sample BCO2) 3 ft. above 1.
3—(Sample BCO3) 1 ft. above 2.
4—(Sample BCO5) 7 ft. above 3.
5—(Sample BCO6) 3½ ft. above 4.
6—(Sample BCO7) 3½ ft. above 5.
7—(Sample BCO8) 3 ft. above 6.
8—(Sample BCO9) 2 ft. above 7.

	1	2	3	4	5	6	7	8
Ammobaculites fontinensis				R				
Citharina heteropleura						R	R	
Cornuspira liasina	F	F						
Dentalina intorta		R	R			R		R
Dentalina oolithica			R					R
Discorbis dreheri								R
Eoguttulina angustata			R	F				
Eoguttulina liassica		F	F			F	F	R
Frondicularia involuta	R			R		R	R	F
Frondicularia nodosaria			R					
Haplophragmium suprajurassicum		R						
Lenticulina munsteri			F	A	A	A	A	C
Lenticulina varians	F	R					R	F
Nodosaria opalini		R			R	R	R	F
Patellina oolithica								R
Planularia anceps ?							R	
Planularia beierana								C
Pseudonodosaria pupoides	F		R	R	R			C
Reophax multilocularis		R	R					
Spirillina infima				R	R			
Spiroloculina lanceolata ?		R						
Tristix suprajurassicum								R
Trochammina globigeriniformis		R						
Trochammina haeusleri			R					
Vaginulina contracta				R				
Vaginulina legumen			R	C	R	R	A	C

Table 12. Foraminifera from the Great Oolite Limestones, Cirencester-Chedworth railway cuttings (Richardson, 1911a).

1—(Sample CTCH6) Taynton Stone, bed 36, about 10 ft. from top (Chedworth).

2—(Sample CTCH7) Taynton Stone, bed 36, about 5 ft. above 1 (Chedworth).

3—(Sample CTCH3) White Limestone, bed 19a (Stony Furlong).

4—(Sample CTCH2) White Limestone, bed 19 (Stony Furlong).

5—(Sample CTCH11) White Limestone, marl layer, about bed 16 (Aldgrove).

6—(Sample CTCH4) White Limestone, bed 14 or 15 (Stony Furlong).

7—(Sample CTCH8) White Limestone, base of bed 14 (Aldgrove).

8—(Sample CTCH12) White Limestone, bed 14, about 5 ft. above 9 (Aldgrove).

9—(Sample CTCH14) White Limestone, bed 8 (Folly Barn).

10—(Sample CTCH15) White Limestone bed 4 or 5 (Folly Barn).

	1	2	3	4	5	6	7	8	9	10
Ammobaculites agglutinans		R				R	R			
Ammobaculites fontinensis		R	R	F	F		F	F		R
Cornuspira liasina			C		F	C		F	C	
Dentalina intorta		F	R		F	R				R
Dentalina mucronata	F					R		R		
Dentalina propinqua	R								R	
Dentalina torta	F									
Discorbis dreheri						R				
Eoguttulina angustata	F	R								
Eoguttulina liassica	F	F	R			C		F	C	
Frondicularia dentaliniformis	R									
Frondicularia involuta										R
Frondicularia spissa								R		
Haplophragmium suprajurassicum		R			R	R	R			R
Lagena striata									R	
Lenticulina galeata					R		R	R		
Lenticulina multangulosa	R	R			R		R			
Lenticulina munsteri				R						F
Lenticulina subalata			R							
Lenticulina varians						R		R	R	

Lingulina dolium	F									
Lingulina sp. A	R	R								
Lingulina sp. C	F									
Marginulina terquemi					R		F	F		
Nodosaria hortensis									R	
Nodosaria aff. issleri						R				
Nodosaria opa'ini	R	R							R	R
Patellina oolithica			R			R	R			
Planularia anceps						R				
Planularia beierana					R					
Planularia breoni	R	R								
Planularia protracta							R			
Planularia sp. A									R	
Planularia sp. B								F	F	
Pseudonodosaria hybrida	A									
Spirillina infima	F					C	R	C	F	
Spiroloculina lanceolata		R					R			F
Triplasia bartensteini		R		R	R		R			F
Tristix suprajurassicum							R			R
Trochammina globigeriniformis						R				R
Vaginulina contracta		R	R	R			F	R	F	
Vaginulina legumen	R	F	R	A	F	C	F	R		
Vaginulina sp.					R	R				R

Table 13. Foraminifera from the Great Oolite Limestones, Hampen railway cuttings (Richardson, 1929, pp. 104-105).

1—(Sample CTH18) Stonesfield Slate Beds, about 22 ft. below top (probably bed 7b).
2—(Sample CTH17) Stonesfield Slate Beds, 4 ft. above 1.
3—(Sample CTH16) Stonesfield Slate Beds, 3 ft. above 2 (probably bed 6).
4—(Sample CTH14) Stonesfield Slate Beds, top of Stonesfield Slate Beds (*Rhynchonella* Bed).
5—(Sample CTH13) Taynton Stone, about 20 ft. below top.
6—(Sample CTH12) Taynton Stone, 5 ft. above 5.
7—(Sample CTH2) Hampen Marly Beds, about 10 ft. below top.
8—(Sample CTH1) Hampen Marly Beds, 2 ft. above 2.

	1	2	3	4	5	6	7	8
Ammobaculites agglutinans				R	R		R	
Cornuspira liasina	C	F		R			F	
Dentalina intorta	R	R	R				R	
Dentalina mucronata			R	R			R	
Eoguttulina angustata			R				R	
Eoguttulina liassica	C	F	A	C	R	F	R	
Flabellamina althoffi		R		F				
Frondicularia dentaliniformis	R		C	R				
Frondicularia involuta							F	F
Haplophragmium suprajurassicum		R		F	R		F	R
Lenticulina multangulosa						R		
Lenticulina munsteri		R		R				
Lenticulina quenstedti			F					
Lenticulina quenstedti var. B		F						
Lenticulina subalata			F				R	
Lenticulina turgida							R	
Lenticulina varians	R						A	A
Lingulina dolium	R		F					
Lingulina laevissima			F					
Nodosaria opalini				R				
Planularia anceps							R	
Planularia beierana			R					
Planularia protracta				R				
Planularia sp. A				R				
Pseudonodosaria hybrida			R	F				
Pseudonodosaria pupoides		R					R	R
Spirillina infima	F	F		R	R	R	C	R
Spiroloculina lanceolata						R		
Triplasia bartensteini						R	F	
Trochammina haeusleri			R					
Trochammina sp.							R	R
Vaginulina contracta							F	
Vaginulina legumen			R	F		R	F	C

Table 14. Foraminifera from Great Oolite Limestones, quarry at Salperton.

1—(Sample CTH9) White Limestone, about 2 ft. above base.

2—(Sample CTH8) Hampen Marly Beds, about 2 ft. below top.

3—(Sample CTH7) Hampen Marly Beds, about 4 ft. below top.

	1	2	3
Ammobaculites agglutinans			R
Ammobaculites fontinensis		R	R
Cornuspira liasina	F	F	
Dentalina intorta		R	
Dentalina mucronata		F	F
Dentalina torta		C	F
Discorbis dreheri			R
Eoguttulina liassica		R	C
Flabellamina althoffii	F		
Frondicularia dentaliniformis	R		
Globulina sp.			R
Lenticulina multangulosa			F
Lenticulina munsteri	R		R
Lenticulina quenstedti var. B ?		R	
Lenticulina subalata	C		
Lingulina dolium			R
Lingulina laevissima			R
Lingulina sp. A			R
Lingulina sp. C		R	
Nodosaria opalini		R	C
Nodosaria sp. B			R
Planularia beierana			R
Planularia eugenii		R	
Pseudonodosaria hybrida		R	R
Spirillina infima	R		
Triplasia bartensteini		R	R
Trochammina globigeriniformis			R
Trochammina haeusleri	F	R	
Vaginulina clathrata eypensa ?	R		
Vaginulina contracta	R	F	F
Vaginulina legumen	R		R

Table 15. Foraminifera from the Great Oolite, Kirtlington Cement Works, Kirtlington.

1—(Sample OXK4) White Limestone, 15 ft. below top.
2—(Sample OXK3) White Limestone, 1 ft. below top.
3—(Sample OXK9) Kemble Beds, 1 ft. below top.
4—(Sample OXK8) Wychwood Beds, 4 ft. below top.
5—(Sample OXK7) Wychwood Beds, ½ ft. below top.

	1	2	3	4	5	6
Cornuspira liasina	R	R	R	F	F	R
Dentalina cf. D. bicornis				R		
Dentalina communis				R		
Dentalina intorta		R	F	F	R	F
Dentalina mucronata		F	R			
Dentalina oolithica			R	C		R
Dentalina propinqua		R	R			
Eoguttulina angustata				R		
Eoguttulina liassica		F	R	C	R	R
Frondicularia nodosaria			F			
Frondicularia spissa			F	C		
Haplophragmium suprajurassicum	R		R			
Lagena striata						R
Lenticulina munsteri			F		R	
Lenticulina subalata			F		R	
Lingulina laevissima			R			R
Lingulina sp. B				R		
Nodosaria hortensis			C	R		
Nodosaria opalini		R	F	R		R
Nodosaria pectinata				R		
Nodosaria plicatilis			R			
Patellina oolithica				R	R	
Pseudonodosaria hybrida			R			
Pseudonodosaria pupoides			R			
Spirillina infima	C	F	R	C	A	A
Spirophthalmidium concentricum			C	R		
Vaginulina contracta			R	C		
Vaginulina legumen	C		R	R		
Vaginulina sp. A			R			

Table 16. Foraminifera from Sharp's Hill Beds, Sharp's Hill Quarry.

1—(Sample OXS5) Lower Sharp's Hill Beds, about 5 ft. below top.

2—(Sample OXS2) Top of Lower Sharp's Hill Beds.

3—(Sample OXS3) Upper Sharp's Hill Beds, about 3 ft. from top.

4—(Sample OXS4) Upper Sharp's Hill Beds, ½ ft. from top.

	1	2	3	4
Cornuspira liasina	F	F		F
Dentalina communis				R
Dentalina conferta		R		
Dentalina cf. D. communis	R			
Dentalina intorta	F	F	F	F
Dentalina oolithica		R	R	
Eoguttulina angustata	R			R
Eoguttulina liassica		R	R	
Epistomina stelligera				R
Frondicularia dentaliniformis		R		
Frondicularia involuta	R	R		
Haplophragmium suprajurassicum	R	R	R	R
Lagena striata		R		
Lenticulina munsteri	A	C		
Lingulina sp. A		R		
Trochammina haeusleri		R		
Nodosaria hortensis		R		
Nodosaria opalini	R	F	R	F
Nodosaria sp. A	R			
Paleopolymorphina pleurostomelloides		R		
Patellina oolithica	R			
Planularia sp. B		F		
Pseudonodosaria hybrida	R			
Spirillina infima	F	C	C	C
Spirophthalmidium concentricum	R	C	A	F
Vaginulina contracta		F	R	
Vaginulina legumen	C	R		F

Table 17. Foraminifera from the Upper Estuarine Beds, Clipsham New Quarry, Rutland.

1—(Sample RuC6) Upper Estuarine Beds about 16 ft. below top, in "*Astarte fimbriata*" Beds.

2—(Sample RuC3) Upper Estuarine Beds, about 8ft. above 1.

3—(Sample RuC2) Upper Estuarine Beds, about 3½ ft. below top.

4—(Sample RuC1) Upper Estuarine Beds, immediately below Great Oolite Limestone.

	1	2	3	4
Cornuspira liasina	F	F		
Eoguttulina angustata	R	F		
Eoguttulina liassica	F	A	A	A
Frondicularia spissa		R		
Haplophragmium suprajurassicum		R		
Lingulina laevissima		R		
Nodosaria opalini		F		
Pseudonodosaria hybrida		R		
Spirillina infima	A	C		
Thurammina tuberosa	R	C		

Table 18. Foraminifera from the Upper Estuarine Beds, Twywell Ironstone Pit.

1—(Sample NHT3) Upper Estuarine Beds, about 9 ft. below top.
2—(Sample NHT2) Upper Estuarine Beds, 4 ft. below top.
3—(Sample NHT0) Upper Estuarine Beds, 2 ft. below top.
4—(Sample NHT7) Upper Estuarine Beds, immediately below top.

	1	2	3	4
Ammobaculites fontinensis			R	
Dentalina intorta				F
Dentalina oolithica				R
Eoguttulina liassica	A		R	
Globulina sp.		R		R
Haplophragmium suprajurassicum		R		
Lagena striata				R
Lenticulina subalata		F	A	
Lenticulina varians		F	R	A
Nodosaria opalini	C			
Planularia sp. B			R	
Pseudonodosaria hybrida			R	R
Spirillina infima			R	R
Spiroloculina lanceolata ?	R			
Vaginulina contracta			R	R
Vaginulina legumen			F	R

Index of generic and specific names